AMATEUR CRAFTSMAN'S CYCLOPEDIA OF *Things to Make*

AMATEUR CRAFTSMAN'S CYCLOPEDIA

AMATEUR CRAFTSMAN'S CYCLOPEDIA

A complete manual for the home-workshop enthusiast with detailed working drawings and instructions for making toys, novelties, sporting equipment, models, furniture, house and garden conveniences, radios, photographic accessories, and scientific instruments — painting — workshop methods — metal working

PREPARED BY THE EDITORIAL STAFF OF
POPULAR SCIENCE MONTHLY

WITH OVER 1400
WORKING DRAWINGS, DIAGRAMS,
AND ILLUSTRATIONS

GROSSET & DUNLAP
Publishers NEW YORK

By arrangement with Popular Science Publishing Co., Inc.

Copyright, 1937, by
POPULAR SCIENCE PUBLISHING COMPANY, Inc.
All Rights Reserved

· PREFACE ·

"WHAT shall I make?" is the question that almost every amateur craftsman keeps repeating. To answer that question with the widest possible variety of authoritative, tested projects, there are assembled in this book a carefully chosen group of home workshop construction articles. The selection was made from the vast store of material that has appeared in *Popular Science Monthly* over a four-year period, and each article has been chosen because of its popularity among home craftsmen.

No one man, however skilled, could write with authority on the large number of topics covered in this book. Articles written by many of the leading contributors to *Popular Science Monthly* have, therefore, been drawn upon in assembling the material. The editors wish to express their appreciation for the privilege of using the fine work of the following authors:

Charles H. Alder
Halvor Anderson
Geoffry Arnold
Joseph J. Aultman
Walter Bach
Evan W. Baker
Roy H. Baldridge
H. Bast
W. W. Baumeister
W. T. Baxter
Frank W. Bentley, Jr.
J. L. Bird
Robert P. Bishop
C. Elmer Black
Stella Bonner
H. J. C. Brodie
A. C. Brown, Jr.
Sam Brown
William E. Brown
M. S. Burleigh
Walter E. Burton
D. A. Butler
J. B. Carter
W. C. Cheney
H. G. Cisin
Donald W. Clark
J. W. Clement
Elton C. Cline
Holt Condon
Joseph C. Coyle
Bruce N. Crandall
Willard Crandall
E. L. Crum
Norman V. Davidson
Maurice H. Decker
Rufus E. Deering
Charles F. Deerwester
Michele de Santis
John H. Dodge, Jr.
Donald R. Doremus
Frank H. Dunn
Joseph E. Edwards
Alfred C. Eitel
C. K. Frankhauser
W. T. Ferguson, Jr.
Raymond S. Forbes
Arthur L. Ford
Kendall Ford
Edward B. Fox
James A. Franklin
Oscar Freeman
S. A. Fritsch
Roy Frost
Harry B. Fuge
Marwood Gardner
J. D. Garfield
M. W. Girard
G. S. Girardet, Jr.
Theodore Gommi
Franklin H. Gottshall
Bill Gredick
C. R. Green
J. S. Hagans
Leo G. Hall
George B. Harran
William Harvest
B. G. Hatch
E. D. Hay
Jack Hazzard
R. J. Heinen
Gerald C. Hennesy
Howard R. Heydorf
Herman Hjorth
Leslie M. Holbrook
I. M. Howard
Davis Humphrey
Dick Hutchinson
Ronald L. Ives
William Jackson
Frank E. Johnson
Garrett I. Johnson
Gaylord Johnson
F. U. Judd
K. F. Keith
C. A. King
W. S. Krehbiel
Paul G. Lackey
Charles A. Laird
Ludwig Stanley Landmichl
Alfred P. Lane
W. E. LeCount
Reginald O. Lissaman
E. G. Livingston
Clifford A. Long
Edwin M. Love
Norton S. Love
G. W. Lownds
Ivan S. Luckman
Arthur E. MacNeill
Albert Q. Maisel
Harland S. Marden
D. C. Marshall
Alexander Maxwell
Capt. E. Armitage McCann
George McClelland
Charles H. McIntosh
A. G. McNeill
Leonard F. Merril
Arthur Miller
Hugh Millikin
W. E. Mitchell
Philip Mooney
Ralph T. Moore
B. W. Morant
Walter K. Moss
Frederick W. Motton
T. E. Murdock
Kenneth Murray
C. L. Newcomb, Jr.
George W. Neidermair
F. L. Nowosatka
Robert J. Nye
Lawrence N. Olsen
Delmar W. Olson
Thomas B. Owens
John Patterson
J. L. Peacook, Jr.
Emil Pearson
L. C. Peltier
P. T. Potter
N. F. Powers
Charles Price
Donald A. Price
D. W. Prince
Edwin Putzer
Guy A. Rafuse
Edward P. Ramage
Paul R. Rannie
Dudley W. Read
Daniel Reynolds
John F. Reynolds
William H. Robba
Clark H. Rutter
John F. Ryan
A. R. Saunders
Charles D. Savage
Frank Schneider
Carl G. Senf
B. G. Seielstad
H. T. Shrum
Hi Sibley
George A. Smith
Carl Sorensen
J. I. Sowers
Harry R. Stabler
R. C. Stanley
Elton Sterrett
Roger B. Stevens
W. E. Stewart
W. H. Stewart
Harold P. Strand
H. L. Swan
Wilfred B. Talman
Philip R. Tarr
Merle Terrill
Edward Thatcher
John Neil Tiffany
T. W. Tizzard
D. R. Tompkins
E. F. Troup
William J. Turnbull, Jr.
F. N. Vanderwalker
Stanley Volchok
Raymond B. Wailes
E. F. Waldron
Ralph G. Waring
Marcus D. Weeks, Jr.
William T. Weld
Ross Wheelton
W. C. Wilhite
Otis A. R. Wood
Richard K. Wood
L. H. Young
Frank Zaic

CONTENTS

I. CRAFTWORK 9

II. GAMES AND TOYS 29

III. OUTDOOR SPORTS 49

IV. MODEL MAKING 91

V. WOODWORKING 121

VI. FURNITURE 147

VII. PAINTING AND FINISHING 173

VIII. SHIPSHAPE HOME 191

IX. METAL WORK 219

X. WORKSHOP HINTS 231

XI. PHOTOGRAPHY 269

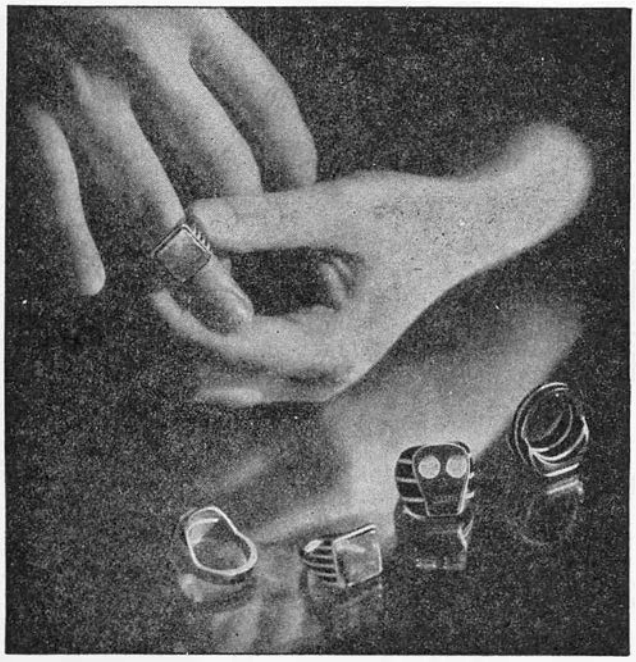
XII. ELECTRICITY AND RADIO 283

XIII. HOME SCIENCE 309

APPENDIX 336

INDEX 339

• CRAFTWORK •



MAKING Colorful Modern Rings FROM OLD TOOTHBRUSH HANDLES

Five typical rings made by shaping a few scraps of celluloid with a few tools that did not cost a dollar

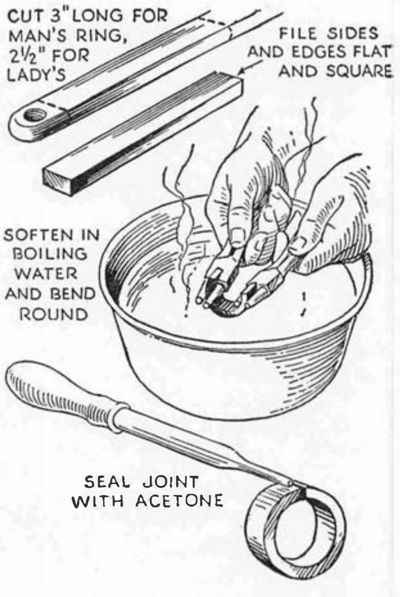
MODERN-looking rings and other costume jewelry of unusual beauty can be made easily by hand from old toothbrush handles, combs, umbrella handles, women's hand-bag handles and clasps, bathroom soap boxes, toothbrush holders and boxes, celluloid buttons and belt buckles, or any other such articles.

If discarded materials are not at hand, a supply can be obtained at any five-and-ten-cent store, or scrap celluloid in various thicknesses and countless color combinations may be bought by the pound from dealers and manufacturers. It is known under many trade names, usually ending in "oid," "ine," or "ite," but the term "celluloid" is loosely applied to this entire group of synthetic plastics. They all have the same general characteristics, being hard, light in weight, tough but elastic and moderate in cost.

Heated to the boiling point of water, celluloid becomes flexible. It can be turned carved, or ground; polished, bent and pressed; stamped, molded, or blown. It is, indeed, one of the most convenient plastics to work with. Only the fact that it is inflammable can be regarded as unfavorable.

Now, if you have found an old toothbrush handle of appropriate color, suppose you try to put it around your finger as an ornamental — and decidedly unique — ring. You can create your own design as you go along, so do not feel that you must follow directions slavishly. The designs shown here are only suggestions to help you begin.

For a man's ring, cut the handle 3 in. long; for a lady's ring, 2½ in. long. Place the piece in a small vise and file the oval-shaped edges flat and even on both top and bottom; then file both sides smooth. Soften the handle in a pan of boiling water for five minutes, and bring the two ends together under water as in Fig. 1 with slender-pointed pliers or tweezers. Remove from the water and seal the seam at the ends with several drops of acetone put on with an eye dropper. Let it stand for half an hour until the acetone welds the ends together.

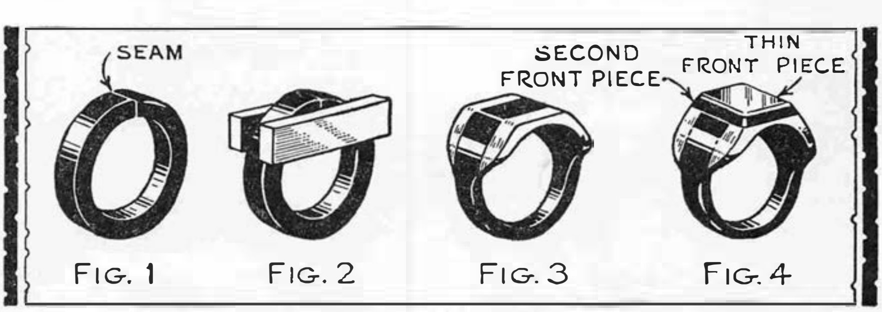

CUT 3" LONG FOR MAN'S RING, 2½" FOR LADY'S
FILE SIDES AND EDGES FLAT AND SQUARE
SOFTEN IN BOILING WATER AND BEND ROUND
SEAL JOINT WITH ACETONE

The toothbrush handle is cut off, filed flat and square, softened in boiling water, bent round, and cemented at the joint with acetone

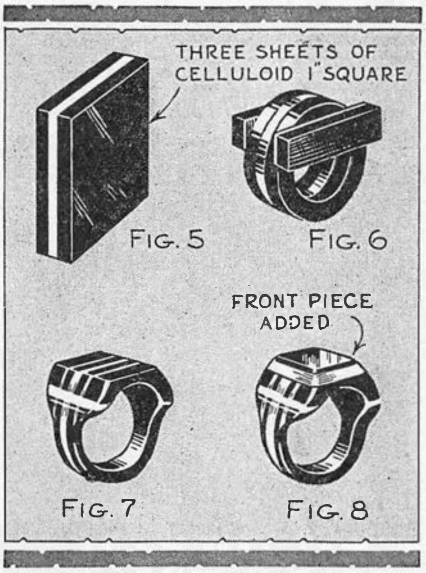
Take another toothbrush handle of a harmonizing or contrasting shade, file down the rounded edges, tops and bottoms until smooth, and cut two pieces about 1 in. long, ⅜ in. wide, and ¼ in. thick. File all sides to a smooth surface and seal the pieces onto the ring (shank) with acetone as in Fig. 2. Let stand for one hour, then shave off any protruding edges on the top and sides with a fine-bladed coping saw, as illustrated in Fig. 3. Use a smooth file to finish the sawed parts to the shape desired and to complete smoothness.

A strip of thin celluloid may be put on the front of the ring, if desired, as shown in Fig. 4, and another layer of contrasting color on top of the first front piece, giving a two-toned top. File this top down after the acetone has taken effect and dried. Finish all edges and sides in any way preferred— square, oblong, oval, or octagonal.

After the ring has been completed thus



Method of making a ring from a strip of celluloid with thinner pieces added. The seam is kept in front so that it can hardly be detected. Endless designs may be worked out in this manner



Rings may also be built entirely from sheet celluloid, the finger hole being drilled out

far, place it in a vise and ream out the inside with a good rat-tail file to the correct finger size. Next, finish the slope between the shank and the built-up portion of the ring, using a half-round file. Work down the outside of the shank with a flat file to the desired thickness; then bevel off the top and bottom edges with a rat-tail file to overcome bulkiness. Study the rings shown in the photographs, as well as Figs. 3 and 4.

The next step is to sandpaper the entire ring with No. 2 sandpaper, inside and out. Follow this with No. 0 sandpaper to smooth out any possible scratches. Get a small amount of pumice stone in powdered form and mix with water to a thick paste, dab this on a cloth lying flat on the table, and work the ring in a circular motion to remove all roughness and bring to a smooth finish. Rinse it with cold water occasionally and wipe with a dry cloth. Continue until all marks of filing are removed. Use the same method to smooth the entire inner and outer surfaces of the ring. The final step is to polish with a dry flannel cloth until a high luster is obtained. A paste wax polish such as is commonly used on automobiles will be found helpful in bringing out an extremely brilliant luster. Strangely enough, the ring will acquire a still more beautiful polish after being worn for a week or two, from contact with the warmth and natural acids of the body.

Variations of this method are possible. For example, if you wish a band of contrasting color running through the otherwise plain shank of the ring, the piece shown in Fig. 1 can be split through the center with a very fine saw and the cut edges smoothed to a perfectly flat surface. A thin sheet of celluloid of contrasting color is then cemented between the two rings with acetone. Similarly, two thin sheets may be placed between the shank and the two thicker pieces shown in Fig 2. A very attractive ring can be made in this way from a black and white comb.

The flat front section of a ring can be further ornamented, if desired, by setting in a stone or by covering it with gold or silver foil, either plain or cut to form an initial, monogram, or design. Foil used in this way should, of course, be covered with a thin sheet of transparent celluloid.

If sheet celluloid is available, it is really easier to build a ring up from it than to use the thick material, although a slightly different method must be followed. The sheets range in thickness from .05 to .25 in. Scraps left over in manufacturing operations may be obtained from any number of firms dealing in synthetic plastics at very reasonable prices. These scraps usually range in size from 2 by 3 to 4 by 8 in. They can be obtained in various thicknesses and in many colors, including beautiful imitations of pearl, mother-of-pearl, veins and mottles, stratifications, roll stratifications, imitation corals, and all colors of translucents, transparents and opaques, grained ivory, shell (plain and corrugated mottle), onyx, wood effects, plaids, checks, stripes, metallic, bronze pearl plain, bronze pearl with fancy blocks, bronze pearl in veins and stripes, and what is called "essence pearl."

WHEN working with scrap sheet material—say ⅛ in. in thickness—cut the pieces 1 in. square and lay three sheets on top of one another, welded with acetone between layers. For example, place black on bottom, saturate it with acetone, place a piece of white on the black, and another piece of black on top of the white. Drip acetone around the four edges to reenforce the outside. Let it dry for half an hour. Then you will have a solid piece ⅜ in. thick and 1 in. square (Fig. 5).

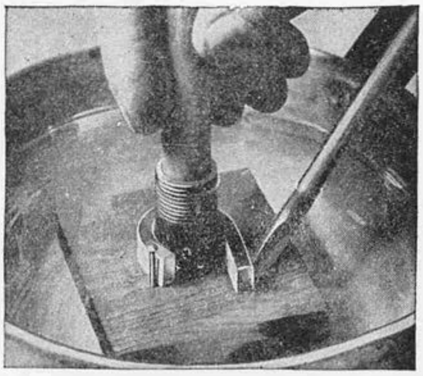
Drill out the center to a size slightly smaller than finger size, place the blank in a vise, shape off the four corners with a coping saw, and round the edges with a flat file. If the shank becomes too soft from the friction caused by the file, lay it aside for half an hour until it regains its natural state of hardness. You will then have a round shank, finished without any joints.

Cut two thin pieces of white 1 in. long and ⅜ in. wide and place one piece on top, across the shank, near the edge, and one on the bottom; then cut a piece of black, the same length and width as the white, and weld with acetone on the top and bottom of the white pieces, but make the black pieces three times as thick as the white (Fig 6). Weld all with acetone. When dry, trim off both sides and top and finish as explained in the first part of this article (Figs. 7 and 8).

DON'T file or sandpaper a ring while it is still soft from the effects of the acetone or from the friction of the file. In the early stage, when the liquid is first applied, the celluloid becomes as sticky as tar. It takes from a quarter to half an hour to dry thoroughly.

NAIL POLISH IS GOOD CEMENT FOR CELLULOID

CLEAR, colorless liquid nail polish is an excellent cement for celluloid, including amateur movie film. A convenient bottle of it, with a brush in the stopper, can be purchased for a dime in department stores. Apply a thin coat of the polish and immediately press together the edges to be joined. Hold the joint firmly for a minute until the cement is dry. A lap joint of ⅛-in. width is usually sufficiently strong.

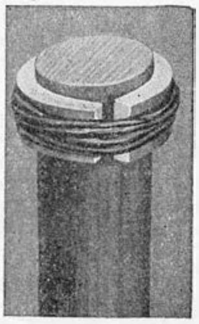


HOW TO BEND CELLULOID WHEN MAKING RINGS

TO MAKE it easier to bend celluloid toothbrush handles into perfect circles, when making celluloid rings, either of the methods illustrated will be found satisfactory.

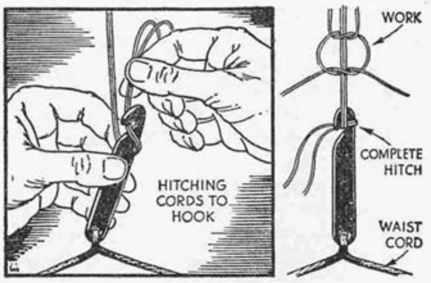
In the one shown above, a short piece of pipe is inserted in a hole in a wood block, and a brad is driven into the block to secure the end of the toothbrush handle. Immerse the block and pipe in boiling water by means of a dowel driven into the pipe. The celluloid then can easily be bent around the pipe with the aid of a screw driver, and it will retain its shape.

In the method at the right, the celluloid is placed in hot water, bent into a U, and fastened around a wood dowel with rubber bands. Dipping the dowel into boiling water will soften the celluloid, and the rubber bands will draw it around to form a circle.



Softened celluloid bound around dowel

KNOT WORK SPEEDED BY SPECIAL HOOK

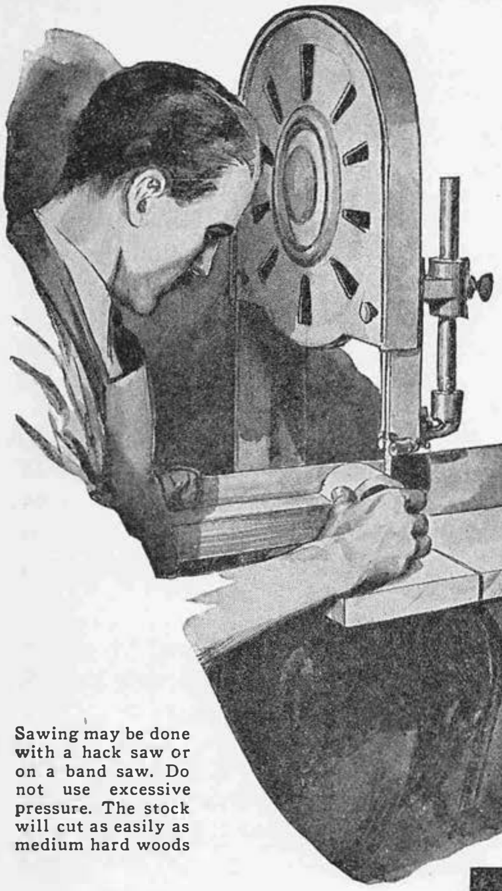


IN square-knot work, a belt hook made as shown from an old toothbrush handle enables one to secure and cast off the "standing" cords much more quickly than is possible with the conventional type of wire hook. The notch can be made with a jackknife and file. The hook is fastened about the waist with a cord.

A little practice will enable one to secure the two cords upon which the knot is to be tied by means of a simple jam hitch, as illustrated. The hitch can be kept from slipping by leaning back slightly.

HOW TO WORK WITH Cast Resins...

A marvelous new material for amateur handicraft



Sawing may be done with a hack saw or on a band saw. Do not use excessive pressure. The stock will cut as easily as medium hard woods

CAST synthetic resins are those brilliantly colored, jewel-like materials used for making costume jewelry, table lamps, clock cases, game sets, and hundreds of other items in which color, translucence, fine permanent finish, and ease of working are important. Unlike most synthetic plastics, they can be machined in the home workshop, requiring only ordinary skill and the familiar tools used to work hard woods or light metals.

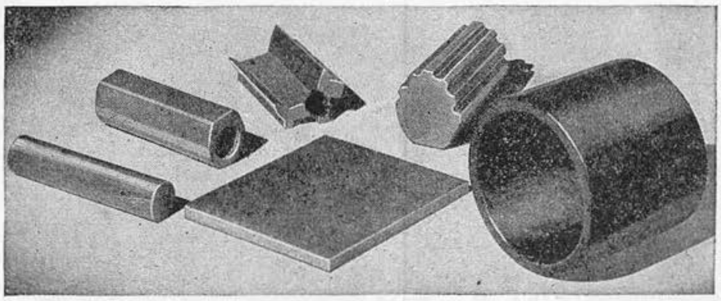
In the hands of the clever home craftsman, they offer unusual opportunities to produce beautiful objects—far more colorful and enduring than most woods, far more appealing to see and touch than cold metal. Until recently their purchase was restricted to manufacturers only, but today a number of firms are in a position to supply the home shop owner with either work kits or single castings.

Cast-resin materials are made in giant kettles as a liquid resin and are then cast in lead molds and placed in vulcanizing ovens to harden. When ejected from the molds, they appear in the form of rods, tubes, sheets, or any of several hundred special shapes. Thus there is very little waste in machining; the craftsman merely chooses the particular casting which most nearly conforms to the shape he intends to develop.

Choice of type and color is also extremely wide. Castings are made in solid colors, in mottles like marble, in light translucent shades, and in completely transparent, water-clear form. Transparent castings are sometimes flaked with tinsel in gold or silver. More than 300 shades and colors are manufactured, though not all of these are available to the amateur craftsman.

In working cast resins, almost every process possible with wood or brass is equally easy to apply. They may be sawed, drilled, threaded, carved, sanded, ground, turned, polished, and cemented. In most cases the process compares exactly with that used in working hard woods. In some instances slight differences obtain. Probably the easiest way to learn how to work cast resins is to follow the process of making one or two pieces of costume jewelry, for jewelry calls for the use of almost every operation mentioned.

One of the accompanying photographs shows several jewelry castings. The large cylinder is a bracelet section, ample for making from three to six bracelets. It is cast so as to be of a size that will slip readily over the average woman's hand.



TYPICAL RESIN CASTINGS

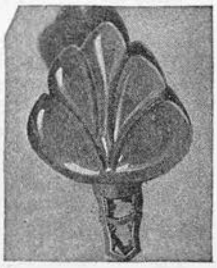
Stock is molded in shapes (from right to left) for making earrings, finger rings, Scottie pins, fancy dress clips, and bracelets. In the foreground is a piece of ¼-in. sheet

The first operation calls for sawing off a section to the required width, which will vary, with your design, from ½ in. to as much as 1½ in. If a hack saw is used, apply only light pressure, to let the powdered chips clear. Place a block of wood within the cylinder when locking it in a vise, so that it won't break or crack under the pressure. If a band saw is available, the cut may be made in a few seconds. The saw should not run faster than 280 ft. a minute, to insure against scorching. If the work is pushed slowly past the blade, a neat, almost polished cut will be secured.

Having cut the section, place it on the expanding jaws of a chuck for turning. If no such chuck is available, turn a wood block to a slight taper, so that the section will slip over it to a tight fit. Lock this block between centers on the lathe, with the cast-resin section in place, and use an ordinary wood-turning chisel, taking a light bite. Hold the chisel edge at or slightly below center, but have the handle higher, as illustrated. The material will machine with a shaving, instead of crumbling like wood.

Some craftsmen who have been working with this type of material prefer to grind their chisels with a bevel on both sides, and if you wish, you may grind a chisel or an old file in that way and experiment for yourself. Start turning with the handle raised well above the cutting edge, and lower it by degrees until you find the angle that gives the best shaving.

The bracelet is now ready for carving. This is done with a regular bench spindle, attached to the power end of your lathe or to any rigid revolving head. Old dentists' drills and cutting wheels or burs can be used if the proper carving tools are unavailable. Professional carvers work from memory, centering their designs by eye. The amateur will do well, however, to sketch his design on the turned bracelet in pencil before carving. Carve the deeper cuts first, then the shallower ones. Take care not to make your cuts too deep or you will weaken the piece and possibly fracture it. After carving, wash the dust away in cold or lukewarm water, using an old toothbrush to clear the crevices. There are two steps to the polishing process: first, ashing or pumice polishing, and second, waxing. If you have a 6-in. buffing wheel of the muslin-disk type, operate it at a speed of about 3,000 r.p.m. If your wheel is larger



Finished bracelet and clip. These are the same pieces seen in process in later photos. The bracelet has been left half carved to show the difference between the smooth and decorated surfaces

or smaller, adjust the speed to compensate accordingly.

In ashing or preliminary polishing, place powdered pumice and water in a shallow pan under the buff so that the wheel just touches the mixture. As you hold the piece to be polished against the wheel, apply some of the "mud" by hand just above the piece, doing this as often as necessary.

Final or wax polishing is done with a similar wheel, using standard waxing compounds or a better grade of powdered floor wax. After polishing, finish off with a soft, dry buffing.

To make a ring, follow the same processes as in the case of the bracelet. Ring rods (such as the second from the left in the photograph of the raw materials) are cast with a center or finger hole having a slight taper. Thus a 6-in. rod will provide about twelve rings having finger holes of various sizes to fit varying hands.

After sawing off the ring section, place it in a vise with the flat face downward, and cut back on either side with a hack saw so that the band between and in back of the fingers will be thinner than the carved face. Then carve, wash, polish and wax just as with the bracelet.

Clips and pins may be made in two ways. A number of shapes are available in standard rodlike sections. These may be sawn off to the desired thickness and then beveled on a sanding belt, a grinding wheel, or with sandpaper, and subsequently carved and polished. If, however, a special shape is desired, sketch it in outline on a piece of paper, paste this on a section of sheet stock—usually ¼ in. thick—and then cut it out on a jig saw. Either a hand fret saw or a power scroll saw can be used. After this, follow the practice previously outlined.

In making earrings it is best to place the round earring rod in a lathe chuck and turn its end to the desired shape before cutting it away from the excess rod. This is necessary because of the small size of the stock.

On pins, clips, and earrings, it is necessary to attach metal parts called "findings." These are of standard types and can be purchased from jewelers or suppliers of cast resins, or may be taken from cheap, dime-store jewelry.

The riveted kind require drilling with a fine drill and the insertion of small self-tapping screws to attach the finding to the cast resin. The simpler pressed-in type can be attached in one or two minutes by the following method: Turn an electric iron over to form a flat, hot table. Heat the back surface of the pin, clip, or earring sufficiently to soften it by holding it against the iron, but take care against overheating, which will spoil the coloring. A heat of about 230 deg. F. is ample. When the piece is softened slightly, the attachment pins of the finding can be forced into the cast resin by applying slow and steady pressure. If no better tools are available, place the two parts in a vise and tighten slowly. Do not hammer the pins into place; a strong hammer stroke may deform the softened resin.

When the finding has been forced into place, the cooling resin will contract over the pins, and a tight and permanent bond will be secured.

WHAT YOU SHOULD KNOW ABOUT Cast Resins

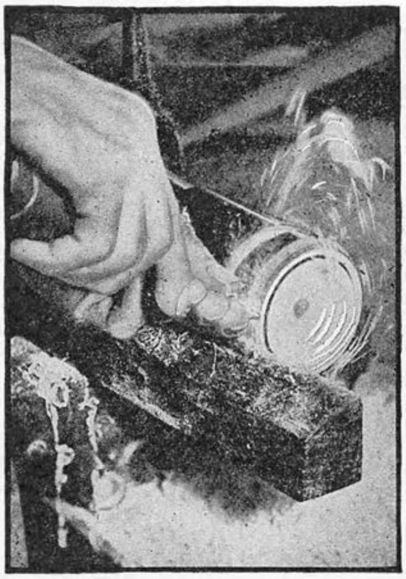
THE MATERIAL. Synthetic resins are cast into rods, tubes, sheets, ring stock, bracelet stock, and several hundred special shapes. They are available in all solid colors, light translucent shades, water clear like glass, and in an endless variety of mottles.

PROJECTS. Costume jewelry, table lamps, clock cases, game sets, book ends, novelty boxes, candlesticks, salt and pepper shakers, jewel cases, trays, photo frames, coasters, handles and ornaments for furniture, desk sets, and innumerable novelties.

OPERATIONS. The material may be sawed, drilled, turned, threaded, carved, sanded, ground, polished, and cemented.

TOOLS. Lathe, jig saw, grinder, polishing head, carving spindle, hack saw, files, and other tools ordinarily used for hard wood or soft metal.

Polishing the carved and washed bracelet. A high-speed muslin disk wheel is used, the wet pumice "mud" being placed at intervals above the object being polished on the wheel


Turning a bracelet on a slightly tapered wooden mandrel. An ordinary, straight-edged wood chisel removes long shavings

Carving is done with a high-speed spindle held at right angles to the cut. Only the lightest pressure is needed to make the cuts

Here are a few of the thousands of designs that may be made from simple resin castings. With this material you can work out countless ideas

Many other types of jewelry may be made by the ingenious craftsman. A study of the designs on display in department stores will suggest many ideas. Link bracelets can be made by cutting the links from two colors of rod stock, drilling these, and then threading them with elastic cord.

Two-color clips can be made by carving or cutting sections to an exact fit and then cementing them in place. Cast-resin dealers supply special cements for this purpose, as it is difficult to stick these materials together securely with any of the adhesives ordinarily used in the home workshop. It pays to obtain the special cement recommended by the manufacturer of whatever make of plastic you happen to be using. For temporary attachment, however, as when fastening a sheet or block of the material to a piece of wood so that it may be screwed to a faceplace without leaving holes in the cast resin, liquid or hide glue may be used. It will not be difficult to remove the material afterwards and wash off any remaining glue.

If transparent, water-clear resins are used—they cost about twenty percent more than the colored types—they can be carved from the back and painted with water colors to give flower or other designs.

A second color may be added to front-carved colored pieces by using sharp and comparatively shallow carving and then, after pumicing, applying a thick film of water color. This should be followed, after the color is fairly dry, a light dry buffing, which will remove the color from the surfaces and leave it only in the carved grooves.

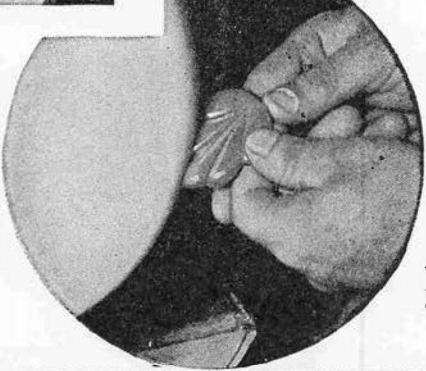
Having covered the beginnings of cast resin work, we come to a more elaborate project, a handsome pipe stand and twin tobacco humidors. Only three stock types of material are required, yet, because of the innumerable colors available in resin castings and because of the wide variety of possible decorations that may be added, each home worker can give the project individuality and make it an outstanding example of fine handicraft.

The required castings are a 6 by 16-in. sheet of ¼-in. thick stock, an 8½-in. long cylinder with an outside diameter of 3 3/16 in. and an inside bore of 2⅝ in., and three ⅜-in. square rods, available in 7-in. lengths, These weigh about 2½ lb. All are standard castings and may be obtained in almost every color, mottle, or degree of transparency. For photographic clarity, the humidor covers on the model illustrated were made from stock of a different color, but an excellent effect and greater economy of material is possible if the base and covers are cut from the same sheet.

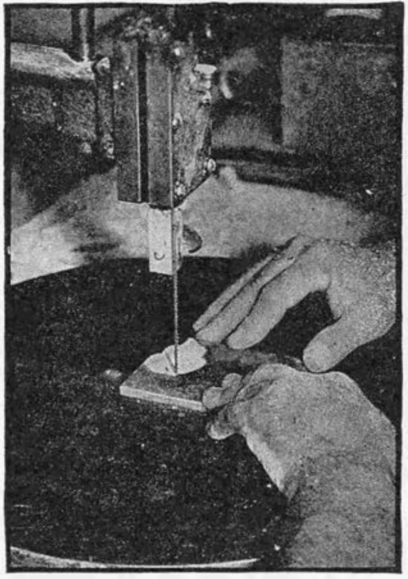
In laying out the base, plan to cut away one section on either end of the 16-in. sheet large enough to permit a circular cover to be jig-sawed from the otherwise waste material. The base is 10 in. wide at the back and 7¾-in. at the front. The curve is best determined by placing the cylinders on the base and following their contours. If a French curve is available, the most pleasing design can quickly be ascertained. To make the cut, use either a hand or power-operated jig saw or a band saw. Finish the cut by holding the edge of the base perpendicular to a sanding wheel or grinding stone. Also round off the corners, using a radius of approximately ½ in. on the front corners and ¼-in. on the back.

If you desire, you may vary the design by beveling the upper edge all around the base to an angle of 45 deg. Use the sanding wheel or a sandpaper block. A somewhat simpler process calls for sandpapering the edge to give a soft, round effect. This is best accomplished by hand with a curved sanding block.

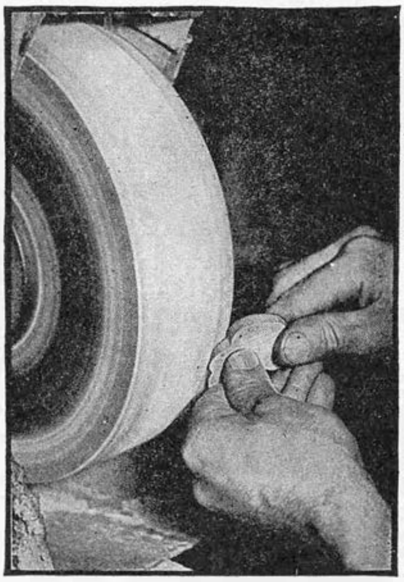
Having cut the base, take the two excess portions of the sheet and lay out and jig-saw the circular cover pieces. These should be sawed to a diameter 1/16 in. greater than that of the cylinders to allow for the final grinding and polishing. Drill a small hole through the center of each disk and countersink it on the underside so that the screw holding the handle in place will not protrude. Then attach the disk to the faceplate of a lathe, with



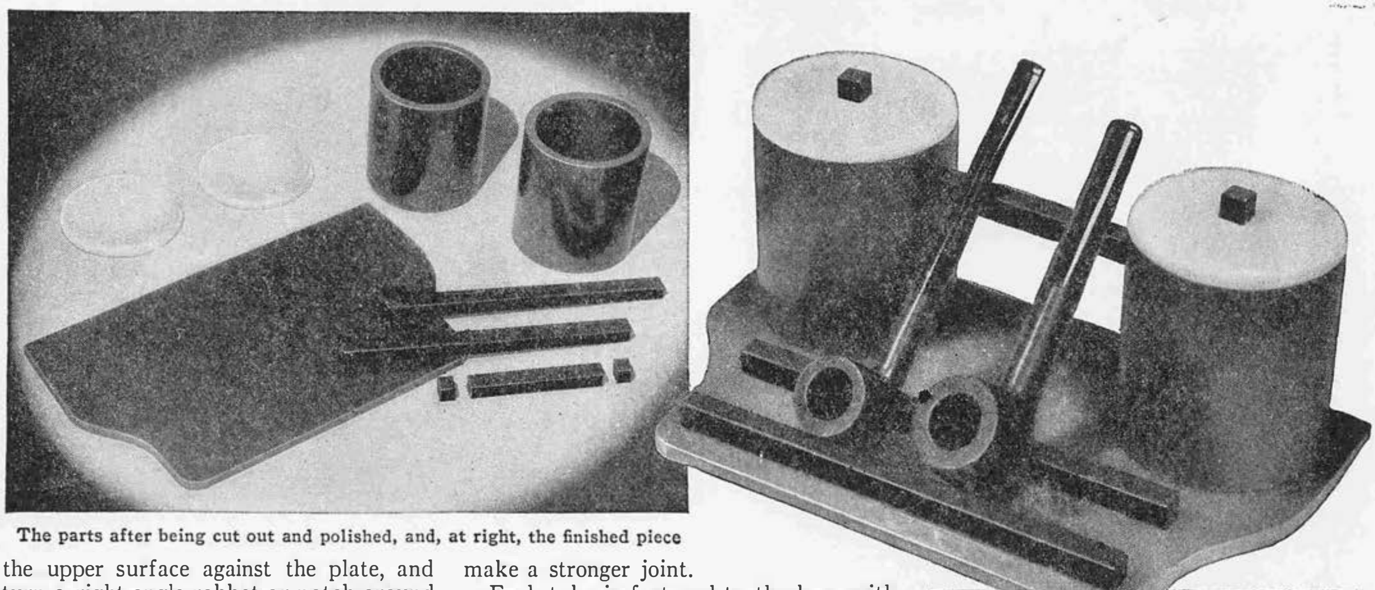
Wax polishing a carved clip. Here again, the higher the speed, the better the polish. This is followed by a short dry polishing



Flat pieces are jig-sawed from sheet stock. The design is cut from paper and pasted on the stock. Caution: Make sharp turns slowly



When cast-resin projects require to be beveled, the work can be done on a wheel, as in this instance, or by hand with sandpaper



The parts after being cut out and polished, and, at right, the finished piece

the upper surface against the plate, and turn a right-angle rabbet or notch around the edge of the disk. This should be about ⅛ in. deep and wide enough to permit the cover to fit snugly into the top of the cylinder. You will find there is a slight variation in the thickness of cylinders, due to a taper of several thousandths of an inch required in casting. The best method to follow, therefore, is to turn the notch very carefully, testing periodically with the cylinder section. A close fit is essential because a humidor should be reasonably air-tight.

THE next step is to cut two 3½-in. sections from the cylinder on a band saw or a circular saw, or by hand with a hack saw. Be certain the cut is exactly at right angles to the side walls of the cylinder. Sand the cut edges smooth. One of the best ways is to use a flat revolving sanding disk in the lathe. The cylinder should be laid in a wooden carriage—a block of wood with two strips nailed to it will do—so that it can be moved along the lathe bed toward the sanding wheel.

The two 7-in. rods that form the lower part of the pipe rack are attached to the base with small screws, rising through countersunk holes in the base plate. The position of the rods will depend on the shapes of the pipes you intend to use with the rack. In the instance shown, the forward rod was set ½ in. back from the front edge of the base, and the second rod 1 in. from the first.

The third rod is cut up to form the crossbar and the two cover handles. The crossbar is 3¼ in. long, and its ends are shaped with a round file to conform to the curve of the cylinders. The ends should be drilled to a depth of about ⅜ in., and holes of equal diameter should be drilled in the two tubes. Here again, the exact height of the crosspiece will vary with your pipes. In the model illustrated, the holes in the tubes were drilled 2⅝ in. above the base.

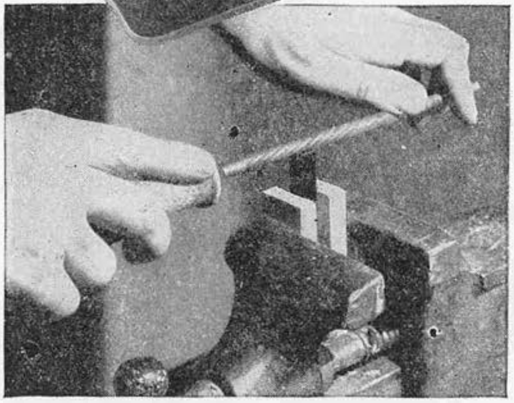
Since it is difficult to countersink holes on the inside of a tube, screws cannot be used to fix the cross piece. However, a satisfactory joint may be made by dipping sections of match stick in glue and setting them in place like dowels. Of course, small hardwood dowels or metal pins will make a stronger joint.

Each tube is fastened to the base with four screws. Holes must be drilled and countersunk in the base, and other holes drilled in corresponding positions in the tube. Drill the tube by using the holes in the base as a jig.

AFTER all the holes are drilled, cut two waxed paper disks of the same diameter as the tubes, place them between the tubes and base, and then work all four to an air-tight fit. Carving or other ornamentation may be added, if desired, and after these operations, the smoking set is completed by polishing and buffing.

One of the most interesting and profitable uses for the new plastic materials is the making of decorative signs and house numbers. The basic steps in fabricating a sign are the same whether it be to identify a professional man's office, mark a rural mail box, or serve as an illuminated house number.

The covers were cut from different stock in this case, but may more economically be made from the waste ends of the base



The crossbar is held between soft wood blocks while the ends are filed to conform to the curve of the humidors

Separate jig-sawed letters, cemented to a back panel of a contrasting color, make a striking sign. If desired, the back panel may be translucent, so that the sign may be mounted in a boxlike frame with a light behind it, to make it readily visible at night.

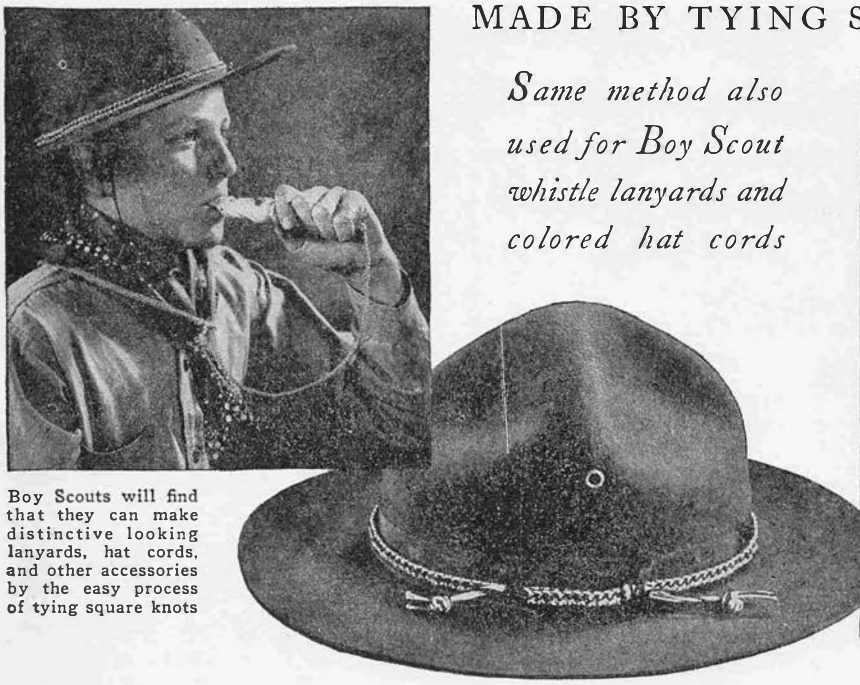
The size and kind of lettering to use depends, of course, on the conditions under which the sign is to be seen. Remember that if a translucent, illuminated sign is to be used, the letters should be a trifle smaller than normally, because the lighting gives an optical illusion of greater size to eachletter. Lettering styles may be obtained from books on sign painting, a printer's sample book of type faces, or from newspaper advertisements. For letters under three inches high, it is best to use "sans-serif" type styles—the kind with an even thickness of stroke throughout the letter. "Thick-and-thin" letters like the ones at the head of this article often look better, but are harder to make.

The letters may be sawed out on a power jig saw, or by hand, and polished individually. The backs should not be polished, because it is preferable to have a slightly rough surface for cementing. Fasten the letters in place with a cement recommended by the manufacturer of the plastic, and dry over a radiator for two hours or more.

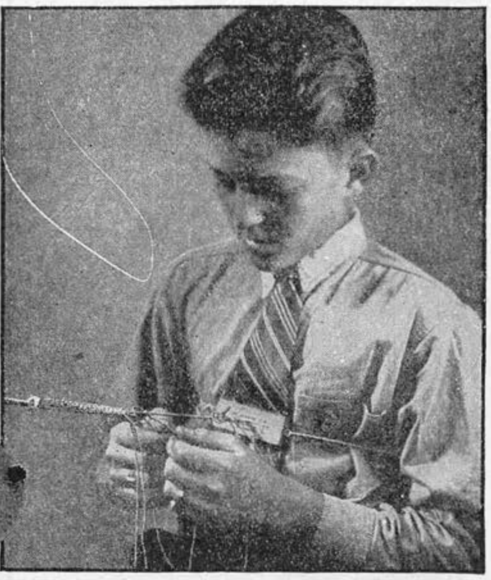
Dog Leashes *and* Watch Guards

MADE BY TYING SIMPLE SQUARE KNOTS

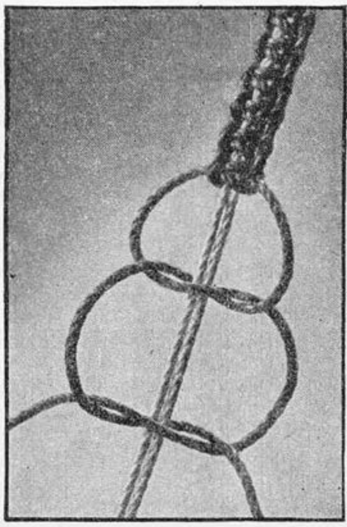
Same method also used for Boy Scout whistle lanyards and colored hat cords



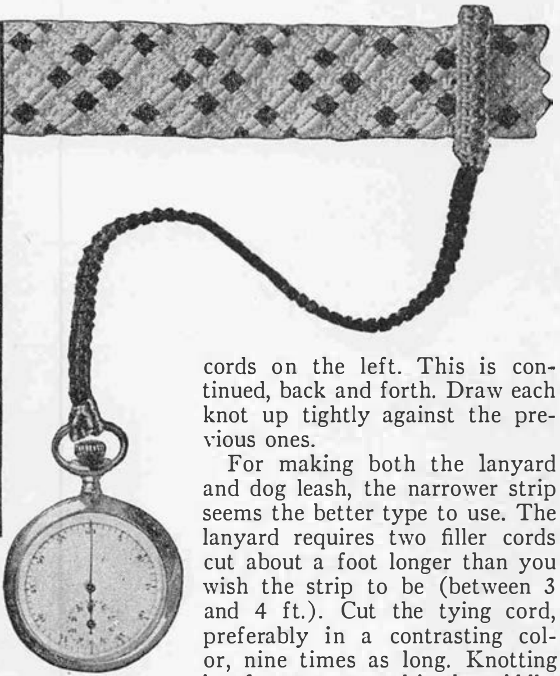
Boy Scouts will find that they can make distinctive looking lanyards, hat cords, and other accessories by the easy process of tying square knots



While knotting, the filler cords are held taut by catching them on a hook tied around one's chest



A narrow strip is knotted by tying a series of square knots around two taut filler cords. The narrow part of watch guard is thus made



MANY practical and attractive articles can be made merely by tying knots in lengths of cord, and the designs shown on this page have been especially selected for ease in making. In fact, anyone can do this simple variety of knot work with complete assurance of success. It will then be possible to branch out into more complicated designs and make such projects as belts, silk pulls for window shades and lamps, men's ties, bath-robe cords, cigarette cases, and key cases.

The cord should be strong and of about the size of a mechanical pencil lead. It can be obtained in department stores everywhere, and is also made in a variety of colors especially for use in knot work.

The lanyard and dog leash are made of narrow knotted strips, pliable yet very strong. Two methods of knotting will be described. The first, which gives a narrow strip, is shown in the center of this page. Tie two cords to the back of a chair or fasten them with a pushpin to the edge of a table. To hold them taut, these "filler cords," as they are called, are caught in a hook fastened to the chest. This consists of a small wood block with screw eyes in either end to which is tied a cord passing around the body several inches above the belt line. A nail is driven through the block with its point turned back on itself to form a hook. The way in which this hook is used is illustrated in the upper right-hand photograph on this page.

After hooking the filler cords, another cord is picked up at the middle and tied around the filler cords as close as possible to the chair or table. A simple square knot is used. Draw up the knot tightly and then make a succession of the same kind of knots around the two filler cords, as shown, until the strip is long enough.

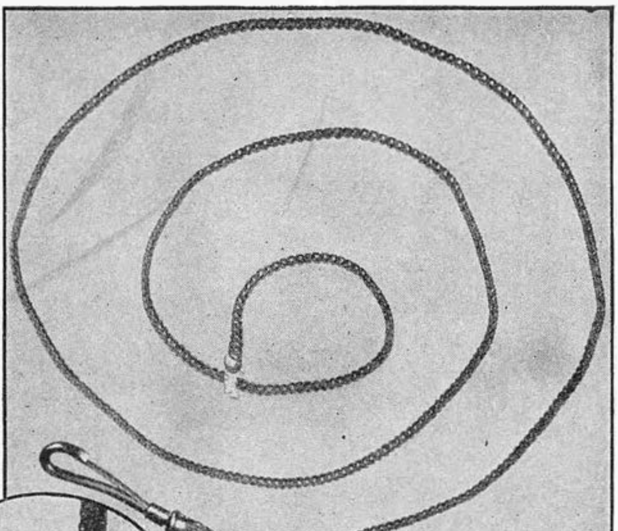
A wider and different kind of strip is shown on the next page, but it is made with the same kind of knots. In this case fasten the ends of six cords to the table. Take four of the cords on the left (allowing the two on the right to fall loose) and fasten the two middle ones to the hook. With the two outside cords of the set of four, make a square knot over the two on the hook. Drop the four cords and take the four on the right, again allowing the two on the left to hang loose. Make the knot as before and return to the four cords on the left. This is continued, back and forth. Draw each knot up tightly against the previous ones.

For making both the lanyard and dog leash, the narrower strip seems the better type to use. The lanyard requires two filler cords cut about a foot longer than you wish the strip to be (between 3 and 4 ft.). Cut the tying cord, preferably in a contrasting color, nine times as long. Knotting is, of course, started in the middle. The leash is made in the same way but about 5 ft. long, and for additional strength use four or six filler cords.

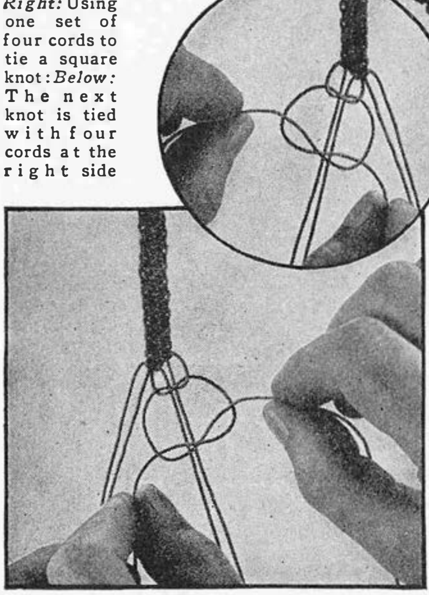
The strips are ended with loops by bending the end back on itself and tying the loose cord ends about the joint securely. At one end the loop is made around the body of the strip to provide a sliding loop for use around the neck in the case of the lanyard, and around the wrist for the leash. Loops on the other ends secure the lanyard whistle and leash snap, respectively.

The neat and servicable watch guard that is shown above combines the narrow and wide styles of strip. You will need two lengths of cord 60 in. long and one

40 in. Double them in the middle and knot sufficient of the wide strip with the six cords to form a belt loop; tie these off securely and cut away the excess of the two shorter cords. The remaining four are used for the narrow strip to a length of about 6 in. Then divide them into pairs and with each tie simple square knots without any filler cord. The ends are passed through the watch ring, brought back to the main narrow strip, and tied firmly. If you wish something exceptionally fine in a watch guard, use a good grade of silk fishline instead of the heavier cord. Other materials will also suggest themselves. Silk cable cord makes especially fine-looking knot-work projects.



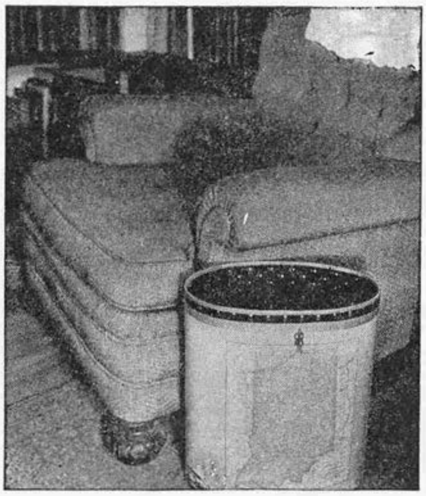
A strong yet light dog leash made with the narrow style of knotting shown on page 76



Right: Using one set of four cords to tie a square knot: *Below:* The next knot is tied with four cords at the right side

The hat cord shown on page 76 is simply a length of the wide strip knotted with six cords and lapped over at the ends. Two strips of the narrow style may also be used, or one long strip of the narrow may be placed around the crown of the hat twice.

The technique of forming long rows of the knots quickly is easily mastered, and is an inexpensive, satisfying hobby.

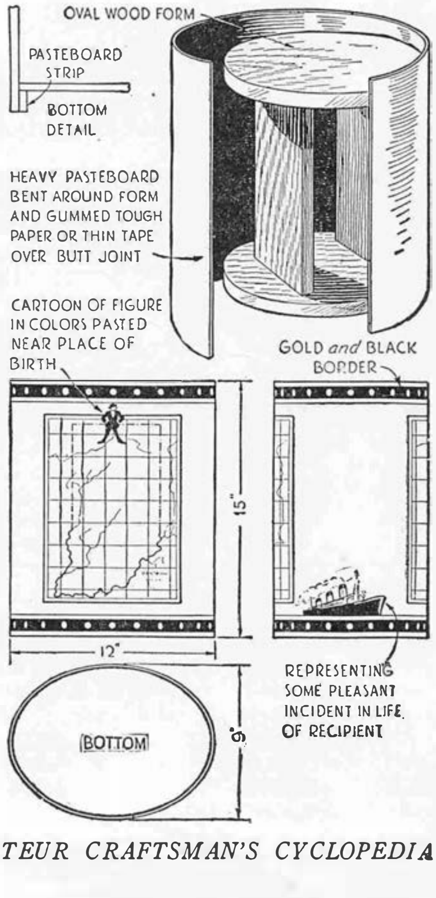


MAPS DECORATE SPECIAL GIFT WASTEBASKETS

THIS unusual and decorative oval wastebasket was designed for an individual couple. One side has a map of the native state of the wife, the other of the husband's.

Such a basket is easy to duplicate. In fact, if a form is made several baskets can be turned out quickly, and each decorated appropriately. Heavy pasteboard is bent around the oval form, and the butt joint is secured with tough gummed paper or tape on each side. Paper is preferred as it forms a smooth joint. If in bending, the pasteboard has a tendency to crack, steam it where the most abrupt curve occurs, and bend very gradually.

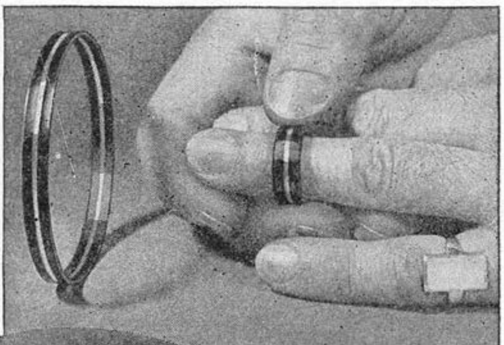
The bottom, of the same material, is set in over a pasteboard strip. After the joints are dry, remove the form and apply the paper covering. Brush the paste on the pasteboard and smooth the paper over it. Orange paper has an effective color.


OVAL WOOD FORM
PASTEBOARD STRIP
BOTTOM DETAIL
HEAVY PASTEBOARD BENT AROUND FORM AND GUMMED TOUGH PAPER OR THIN TAPE OVER BUTT JOINT
CARTOON OF FIGURE IN COLORS PASTED NEAR PLACE OF BIRTH
GOLD *and* BLACK BORDER
15"
12"
BOTTOM
9"
REPRESENTING SOME PLEASANT INCIDENT IN LIFE OF RECIPIENT

JEWELRY MADE FROM CELLULOSE TAPE

COLORED cellulose tape or ribbon, in the widths used for tying packages, can be used for making novel and durable yet light rings and bracelets. The ribbon is made in many styles and color combinations, so that a color to match any costume can be selected.

Cut a wooden disk of the proper diameter for forming the bracelet, and use a dowel or other round stick as a core for winding the ring. As the ribbon is wrapped around the form, coat it freely with transparent cellulose household cement thinned as necessary with acetone, or a cement made by dissolving scraps of transparent celluloid in acetone. From fifteen to twenty-five turns are necessary, according to the thickness desired. Lay the completed rings and bracelets aside to dry overnight before using them.



A colorful ring and bracelet to match formed by cementing together cellulose ribbon

How the ring was made by winding the tape around a wooden stick for about twenty-five turns and fastening the whole with transparent cement

Cellulose Scotch tape, which is adhesive on one side, also may be used for many decorative purposes, and it can be used without cementing.

KNOT-WORK
Slippers
for Summer Lounging
for Beach Wear
for Bathing

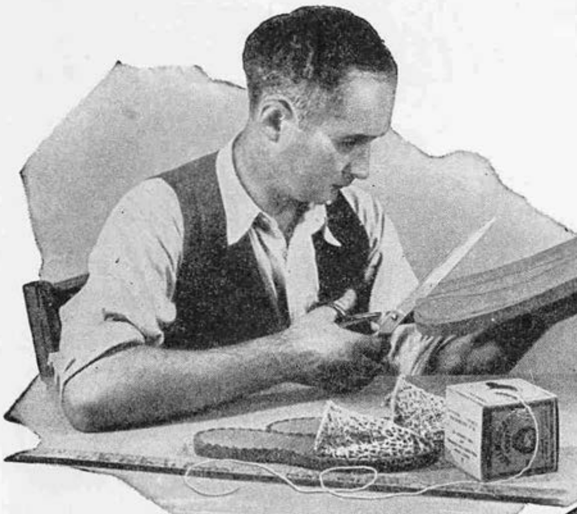
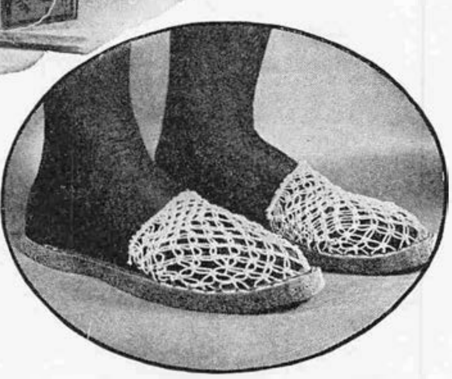


Fig. 1. The soles are marked on a sponge-rubber chair or knee pad and cut out with large shears. *At right:* Completed slippers



THE wearing of these novelty bath slippers, or mules, gives an impression of walking on thick, luxurious rugs such as no cold bathroom floor has ever boasted. A pair can easily be made by tying square knots in cords attached to a pair of soles cut from a sponge-rubber pad. They can be changed from mules to soft, spongy beach shoes merely by carrying the knotted cords farther to the rear, around the heel. For ordinary outdoor wear, the cords may be knotted to thin leather soles, to which you can attach ten-cent rubber half soles and heels, obtainable in any department store.

To make a pair of bath slippers like those shown in the oval above, get a 25-cent sponge-rubber chair or knee pad, such as are sold, in different colors, at department stores. They are made in thicknesses ranging from 3/8 to 1/2 in. Use a pair of shoes as a pattern and mark around them, on the pad, with a crayon pencil. In cutting out the soles, use large shears, but make only short cuts (Fig. 1.).

Now thread a large darning needle with a length of black knot-work cord, and stitch the edges of the soles as shown in Fig. 2. Make the stitches wider on the top of the sole, and slant the needle to the inside as it is pushed from top to bottom.

Twenty 5-ft. lengths of strong white cord were used in making the uppers of the slippers illustrated. Of course, you may also use colored cord, or silk cable cord, if you wish. Each cord, after being doubled, is anchored to the sole stitching as shown in Fig. 3.

Starting with the four cords at one side, make widely spaced square knots by tying the outside cords over the inside cords of each set of four, as shown in Fig. 4. This is continued until the toe covering is partly knotted, when the slipper should be fitted to the foot (Fig. 5). You can get a perfect fit by making the knots closer or wider apart. This is very important. Fit the slipper often, and space the knots accordingly.

After the toe part is well under way, carry the knotting back, towards the heel. Fasten the work down at each side (see Fig. 6) so that the knots in the middle can be made more easily. After all twenty of the cords have been knotted, it will be necessary to anchor each row of knots to the sole by passing the cords on the sides through the loops of stitching.

When the knotting has been carried on as far as necessary, it is finished off with a row of half-hitches (Fig. 7). Take a loose cord from one side and bring it across the width of the slipper, over the instep. With each of the other loose cords, make from one to four half-hitches over the single cord, as may be necessary for the correct length of the row. Pull the half-hitches (which are ordinary "granny" knots) up very tightly. From the underside, cover them with ordinary nail polish, which will penetrate quickly and, in drying, make the knots very hard. You can then cut each cord off closely with a razor blade.

The slippers might be completed here, but it is better to add a thin leather sole to protect the stitching cord from wear. Rubber cement may be used, but a stronger material, an adhesive of a strength

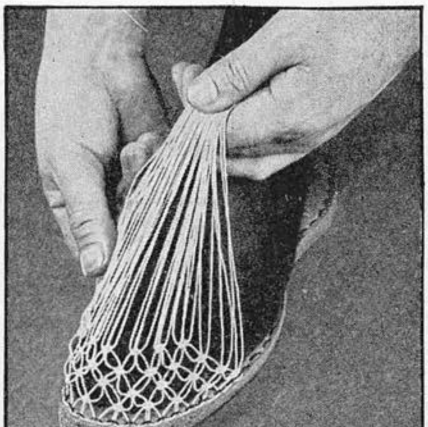


Fig. 5. As the knotting proceeds, the slipper should be fitted to the foot. Then the knots may be spaced closer or wider as found necessary

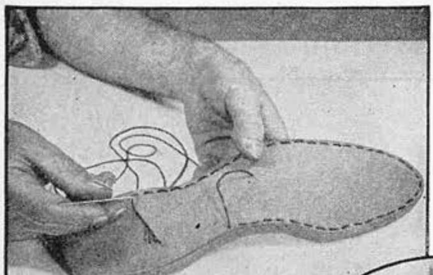


Fig. 2. Stitches should be made around the edges of the soles with black knot-work cord in a large darning needle. Have the stitches on the top wider and closer to the edge

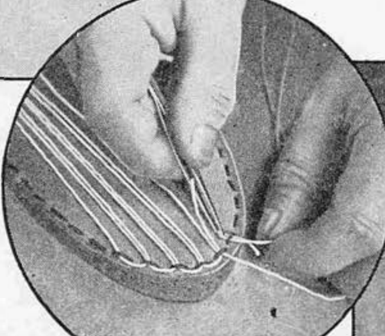


Fig. 3. Twenty lengths of white or colored working cords are used. Each should be doubled and slipped under one of the sole stitches

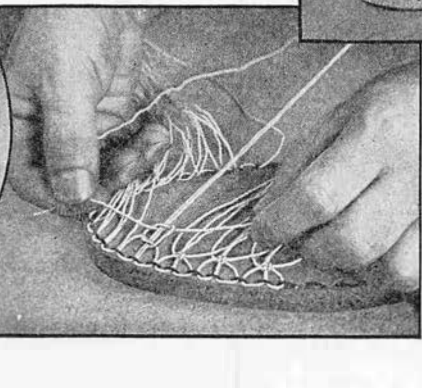


Fig. 4. Widely spaced square knots are made with each set of four cords, the two outside cords being tied over the inner cords. Continue until the covering is partly knotted

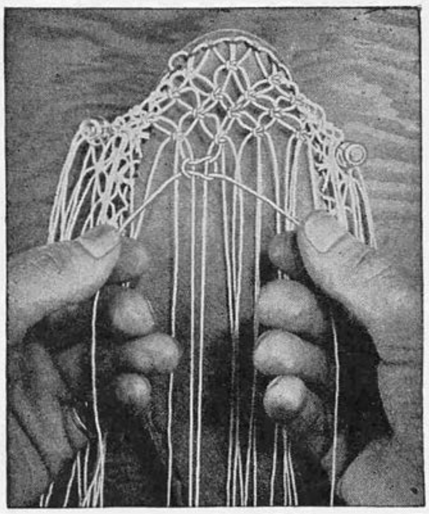


Fig. 6. The work is held with pushpins on each side while the center knots are tied

which will hold the stitching securely, is thick, waterproof casein glue. Mix a tablespoonful of the powdered glue with an equal quantity of water, and let it stand for fifteen minutes before using. Spread this in a thin film on the bottom of each sole, making sure that each stitch becomes soaked with it. Press each sole into contact with a piece of light leather, and weigh them down for twenty-four hours until the glue has completely set. The excess leather is then trimmed off with scissors or a razor blade.

If you wish cool outdoor shoes that will stand more than the usual wear, use lightweight leather for the soles, instead of sponge rubber. After the uppers are knotted, cement a pair of ten-cent composition half soles in place, and attach a pair of rubber heels.

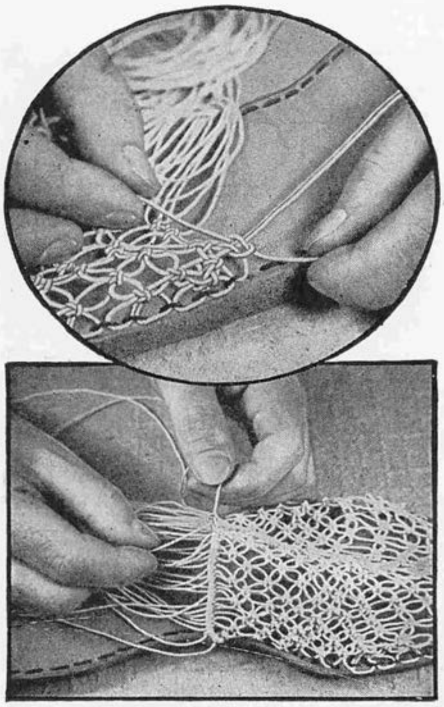
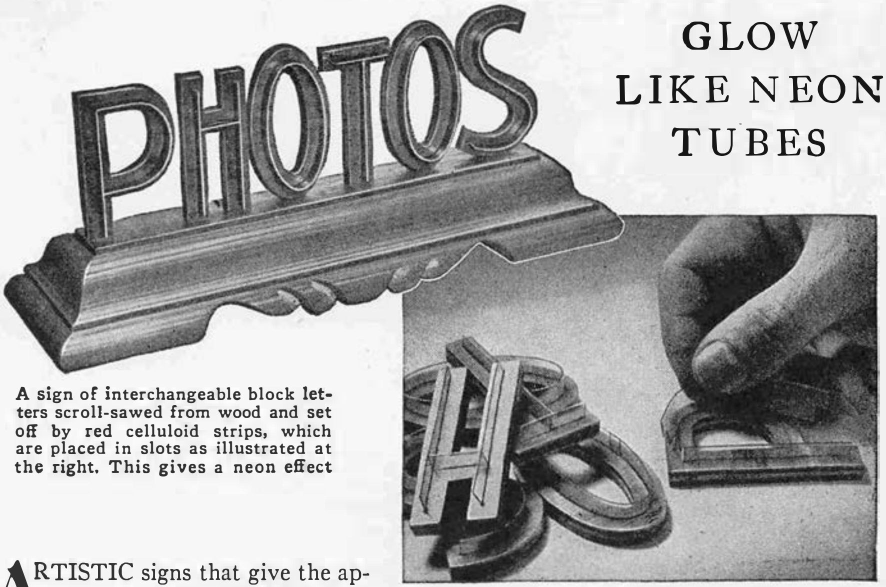


Fig. 7. The upper photo shows how the sides of the uppers are anchored to the stitching after the twenty cords have all been knotted. The uppers are finished (lower view) with a row of half-hitches made with the loose cords over a single cord brought across the instep

Colored Celluloid Letters

GLOW LIKE NEON TUBES



A sign of interchangeable block letters scroll-sawed from wood and set off by red celluloid strips, which are placed in slots as illustrated at the right. This gives a neon effect

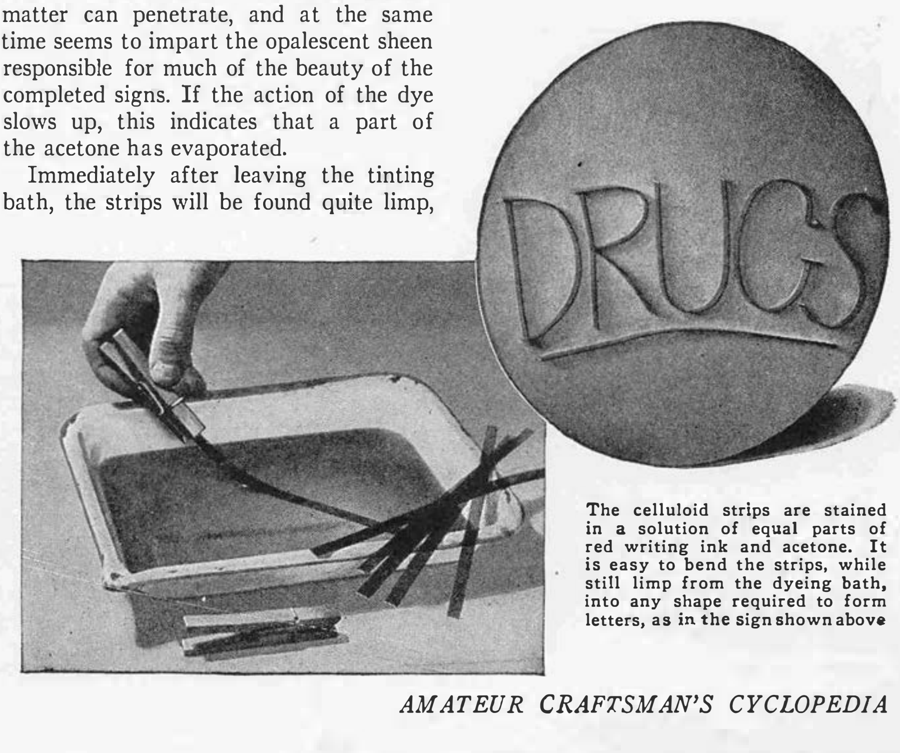
ARTISTIC signs that give the appearance of glowing neon tubes can be made from narrow strips of red celluloid. The effect depends on an optical illusion, and is quite realistic. If the sign is placed in a favorable light, it requires a reasonably close examination to reveal that the letters are not in some way illuminated by electricity.

The letters, for ordinary use, can be attached with waterproof cement to glass or any light-colored surface.

Automobile side-curtain celluloid is satisfactory for the purpose, if it is cut into strips about 3/8 in. wide. The red color is applied by dipping, and to avoid staining the hands use wood or metal clips, as shown in one of the photographs below. The solution consists of one bottle of red writing ink, to which is added an equal quantity of acetone. The latter softens the celluloid so that the coloring matter can penetrate, and at the same time seems to impart the opalescent sheen responsible for much of the beauty of the completed signs. If the action of the dye slows up, this indicates that a part of the acetone has evaporated.

Immediately after leaving the tinting bath, the strips will be found quite limp, and in this condition they can be formed into letters and numerals quite easily. They will retain their shape permanently when dry. The letters in the sign advertising drugs were shaped in this manner and then fastened with cellulose cement to a disk of wall board.

Block letters for making signs such as the one at the top of the page are cut on the scroll saw from plywood and then varnished. Instead of cementing the celluloid in place, a thin scroll saw blade is used to cut slots into which the strips can be fitted, as shown in one of the illustrations. These letters can be used anywhere. It is not necessary that the letters be given special attention as regards lighting, as the effect is practically the same in daylight and in artificial light.



The celluloid strips are stained in a solution of equal parts of red writing ink and acetone. It is easy to bend the strips, while still limp from the dyeing bath, into any shape required to form letters, as in the sign shown above

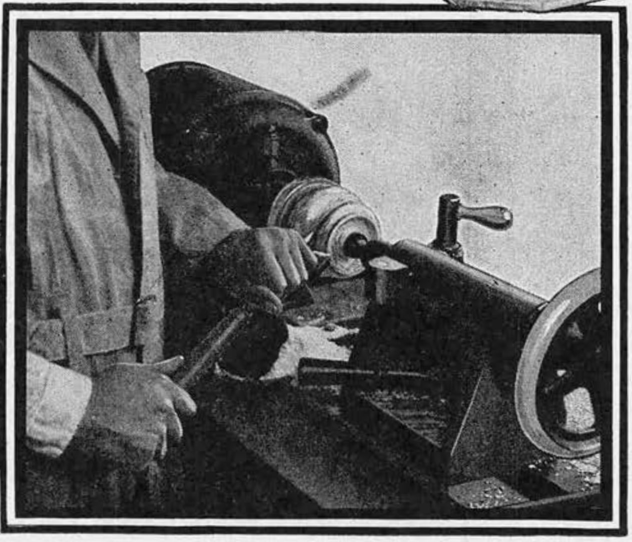
Artificial Marble Novelties

TURNED IN LATHE LIKE WOOD

Two decorative flowerpots that closely resemble marble but are really made from an inexpensive plaster mixture

COLORS GIVE MARBLE EFFECT

The special cement is mixed with water in such a way as not to stir in too much air. Then dry limeproof plaster colors are added to produce a pattern that looks like marble



IF YOU are looking for something really new to make in your home workshop or at school, you should experiment with turning artificial marble. This fascinating handicraft has many advantages. An important one is that the material is quite inexpensive and is obtainable everywhere. You can have the fun of making a number of things at the cost of only a few cents. In spite of their low cost, however, the finished articles are useful, novel, and beautiful. They never fail to elicit the admiration of all who see them.

Even the most inexperienced amateur can achieve success with the more simple forms, yet the most skillful worker will find a challenge to his liking. The possibilities in both design and craftmanship are practically unlimited. If you have a lathe and a few common hand tools, you need no other equipment. Finally, but not of least importance, the articles have sales value. Any man of skillful and ingenious bent may turn his pastime into ready pocket money.

If you would like to try your hand at making some of the attractive pieces illustrated, the first step is to go to any lumber dealer or building supplies firm and purchase about ten pounds of Keene's cement. The superfine grade is best, but the regular grade is very nearly as good and is less expensive. Ten pounds should cost about twenty-five cents. At the same place buy about a quarter of a pound each of two or more limeproof plaster colors. These are mineral colors in powder form and may be had in a variety of hues. Do not buy cement colors.

It is wise to select a simple piece for your first attempt. A pin or paper-clip tray or an ash tray is suitable.

To make a form in which to cast the cement, cut a circle about 3½ in. in diameter from any scrap wood from ¼ to ¾ in. in thickness. Attach it to a lathe faceplate, using screws that are long enough to extend about ⅜ in. through the wood for the purpose of holding the cement. Place the faceplate on the lathe and true up the wood. The wood should now be given two or three coats of lacquer to make it impervious to moisture. If you do not have lacquer, however, use hot paraffin, paint, varnish, oil, or shellac.

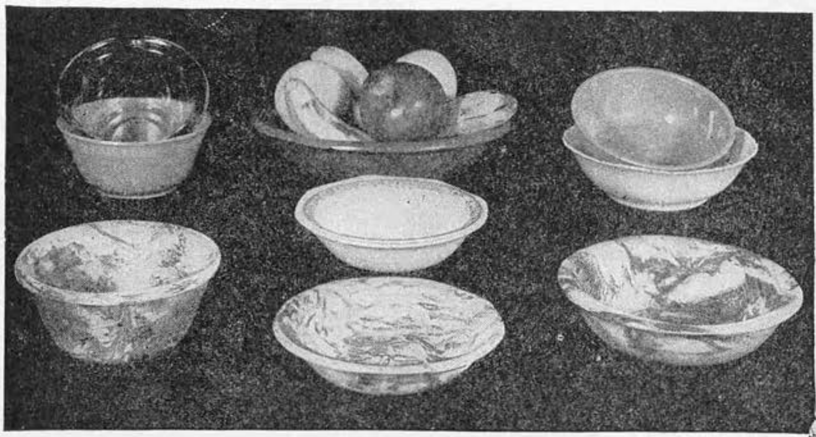
The cast for the pin tray need not be more than 1 in. thick. Cut a piece of light galvanized iron long enough to encircle the wooden disk with about a ½-in. lap. The width should be 1 in. plus the thickness of the wooden base. Attach this to the periphery of the disk with three roundhead screws to form a shallow cup. Lacking galvanized iron, you may use tin or even cardboard.

MELT some paraffin and add an equal amount of kerosene. When this is cool it will be about the consistency of paste shoe polish. Coat the inside of the form with this "dope." Of course, linseed oil or machine oil will serve the same purpose.

For mixing the Keene's cement, you will need a shallow granite pan or a mixing bowl, a large granite or a heavily tinned spoon, and a cup of water. Putty knives or even old case knives are convenient for handling the colors. The cement needed to fill the form and the required amount of water are easily determined by a little experimenting. Roughly, the amount of cement by volume will be a quarter more than the amount of dry cement required to fill the form, and the amount of water will be about one third of the volume of cement.

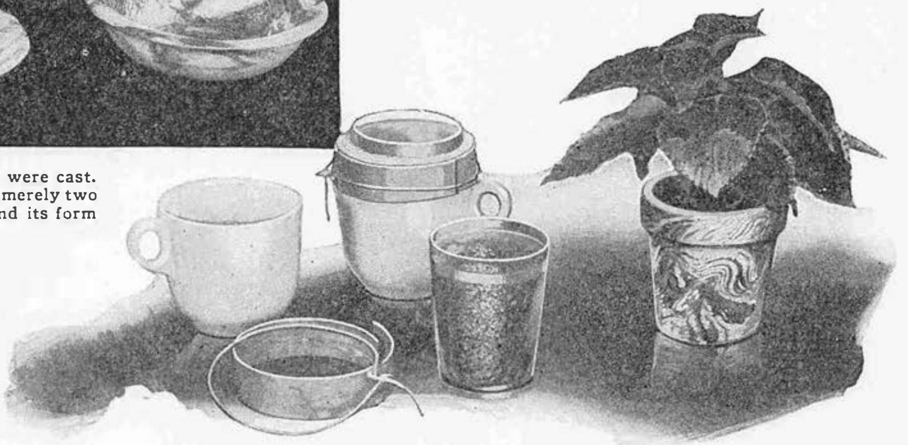
Place the cement in the pan, add the water, and mix it thoroughly for several minutes. Do the mixing quietly, keeping the spoon submerged in order to avoid stirring in too much air. Do not beat it. The consistency of the batch should be quite quakey, but hardly thin enough to pour.

To add the colors, simply take a little on the end of a putty knife and cut it into part of the batch. Take care that no lumps of dry color are unbroken. A dif-



Many bowls can be completed without a lathe . . . These attractive shapes were cast in molds made of kitchenware

Several finished bowls and the forms in which they were cast. The form for the fruit bowl, although not shown, was merely two common vegetable bowls. *At right:* The flowerpot and its form



ferent color may then be mixed into another part of the batch. The marbleized effect is obtained by stirring these colored areas together just a little or by mixing them as you fill the form. Many attractive color combinations may be worked out with a little experimenting.

IN THE process of filling the form, stop occasionally and bang it rather hard several times upon the bench top to jar out the air bubbles. When the form is full, cover the top with paper or a damp cloth to prevent excessive drying of the exposed surface. Put the cast away to set from eighteen to twenty-four hours. It should be firm, but should cut easily when ready to turn.

Select a simple design for the pin tray and make a full-size drawing of it. Remove the metal or cardboard form from around the cast, and screw the faceplate on the lathe. Work as you do with wood, using the same tools or improvising tools from scrap steel or files. If the cement is at the right stage, not too hard, it can be cut with surprising ease and will not dull the tools as quickly as does wood. The cement cuts smoothly at a slow speed of about 1,200 R.P.M., and at that speed it is not apt to fly off the faceplate.

When the cutting is done, the piece should be removed from the faceplate and allowed to dry for another twenty-four hours. It is then polished with No. 6/0 or 8/0 sandpaper. If you attempt to sand it while damp, the colors will smear. If you can get No. 7/0 wet-or-dry (waterproof) sandpaper, it is better to polish the Keene's cement under water in a lavatory or large pan. Carborundum stones of fine grain may be used for polishing flat surfaces under water.

By exercising ingenuity in building the forms, you may make larger articles such as candy or nut dishes, powder or jewelry boxes, cigarette containers, flowerpots, bulb trays, candlesticks, and table lamps. Several such articles and the forms used in their construction are illustrated in this article.

The little hanging ivy pot is made over a pyrex custard cup which has the rim set very tightly in a groove in the wooden base as shown in one of the photographs and a drawing. It is necessary to turn only the outside. When dry, the cement cup slips readily from the glass. Such a device makes it possible to save a great deal of time and a certain amount of material.

When removed from its form, the casting is rubbed with waterproof sandpaper, used wet

Flowerpots made of Keene's cement have one bad feature. They are not waterproof. Water not only seeps through them, but it causes a rough precipitate to gather on the surface. If you wish to set the plant directly in the pot, it should first be coated on the inside with liquid rubber. To avoid making a hole in the bottom of the pot, place a false bottom of galvanized iron about ¼ in. from the bottom. The false bottom is punched full of holes, and extending from it there is a small tube reaching above the surface of the dirt. This serves to carry water and air to the roots and makes for a generally healthy plant condition.

The form for the cigarette holder is prepared in a similar way. A small cylinder, closed at one end, is made of copper and used as an inside form like the custard cup except that it is not removed, but becomes a copper lining in the cigarette jar.

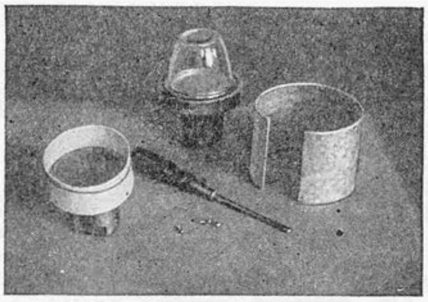
The book ends are turned as one piece and sawed in two with a hand saw while still soft. The resulting rough surfaces are ground down with a sharpening stone under water. They are sanded again with very fine paper when thoroughly dry.

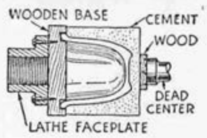
By the simple expedient of making a form 4 or 5 in. deep, several ash trays or pin trays may be made from one casting. They are turned one at a time and cut off. The grooves for cigarettes may be put in the rim of the ash trays with a gouge or a round file.

Other ideas will suggest themselves to you as you progress with this work.

The man who does not have a lathe need not feel excluded from artificial marble craft. Numerous attractive bowls, pots, and other objects can be produced by casting them directly in the final shape, leaving only a little smoothing and polishing to be done by hand.

Suppose you selected a small flowerpot as your first piece. The form is easy to assemble. Simply use a jelly glass and a teacup that is at least ½ in. larger in diameter and rather tall. The one pictured was purchased for five cents in a dime store and is of 3⅜-in. inside diameter and is 3¼ in. tall. To complete the form, cut a strip of tin or light galvanized iron about ¾ in. wide and long enough to encircle the

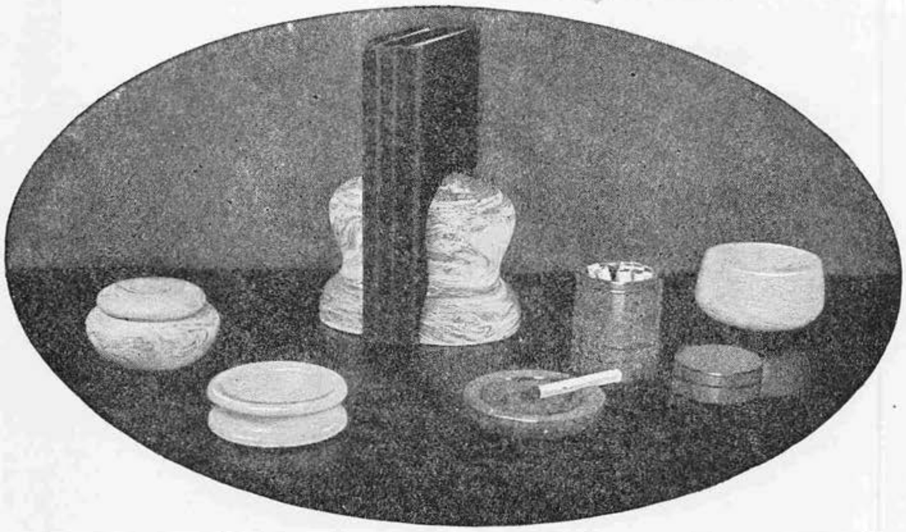




A tray form; inner and outer forms for a small ivy pot; and, right, how the ivy pot was set up in a lathe to be turned

Keene's cement, a material often used by plasterers when they need something harder and smoother than common plaster, is mixed with water, colored with plaster colors, and cast in forms made from ordinary kitchen utensils

The method is so simple and inexpensive that it may also be used for casting play dishes for children's tea parties. It doesn't matter then how many dishes are broken; any number of new ones can quickly be made



A few examples of artificial marble work. The book ends were turned in one piece, then cut in half with a hand saw. The cigarette holder has a copper lining around which the marble mixture was cast before any turning was done. Each piece is beautifully colored

top of the cup above the handle with a good lap. Hold this collar in place with wire or strong cord. Now set the glass inside the cup and measure to ascertain how high it needs to be to give about 3/8 in. space in the bottom.

After the form has been used to determine the amount of cement needed, as described before, the cup should be coated on the inside with "dope," and the jelly glass on the outside. The glass should be nearly filled with sand to hold it down in the cement.

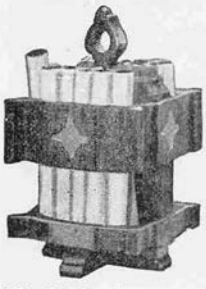
Place the cement in the cup, and bump it against the table to jar out the air bubbles. Set the glass carefully in the center of the cement, and press it down to the desired depth. This should squeeze the cement up around the glass to the top of the band around the cup. See that the glass is centered, wipe off any overflow, and allow the cement to set.

After twenty-four hours, you will be able to remove the mold by pouring hot water in the glass. Remove the rough edges with waterproof sandpaper, used under water, and polish.

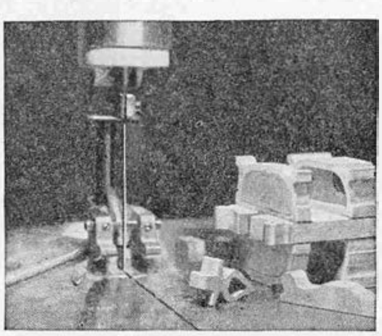
NOVEL JIG-SAWED CIGARETTE HOLDER

THOSE who wish to try something new in the way of a jig-sawed project will find this cigarette holder a novelty that is at once interesting to make and useful when completed. A number of them can be made up for Christmas presents.

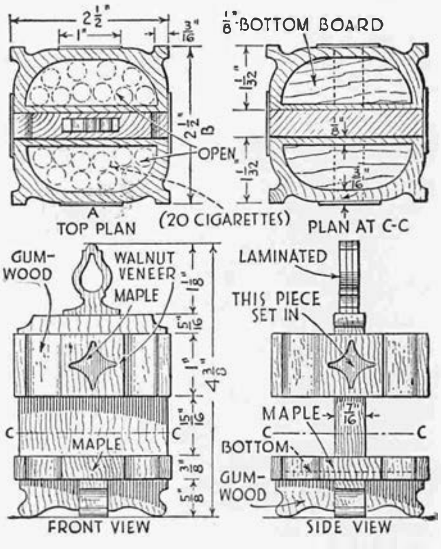
The holder is made of gumwood, each half being cut out on a jig saw and glued to a solid centerpiece 7/16 in. thick, as shown in the accompanying drawings. Each section holds ten cigarettes. The top piece, which is 1 in. high, is the same shape as the lower piece, but the latter is only 3/8 in. high. The grain of the wood is vertical in these pieces. A 1/8 in. thick bottom is glued in each half of the lower piece.



The holder is easy to pass around and also will keep two different brands of cigarettes separated



Cutting the parts for the holder is very much like making a picture puzzle

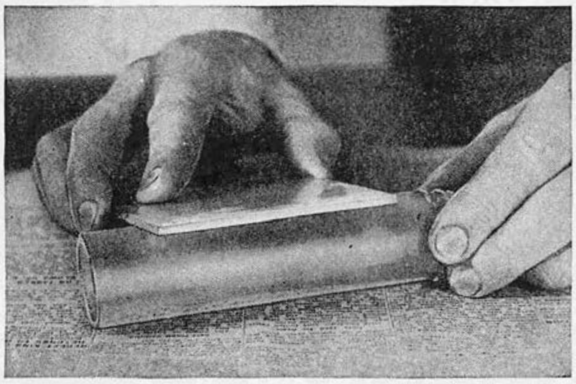


Walnut veneer with maple inserts is glued on the upper part of each side to add interest to the design and to cover the joints between the centerpiece and side sections. The same expedient is used to hide the joints in the lower part of the holder, but only maple is used here.

Water-color oil stain was brushed on to darken all the wood but the maple inlays, and then two coats of thin shellac were applied for a finish.

MODERN-LOOKING Novelties from Old Bottles

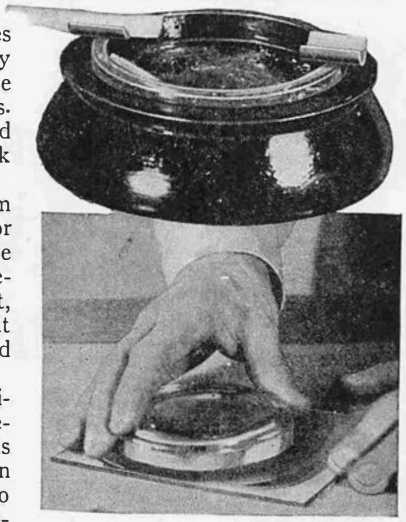
Electric candlelight. The tube—an old medicine container—is frosted with emery and water as at right



SMART, modern, and distinctive novelties may be made from old bottles by any woodworker with a lathe for turning the wooden bases, tops, and other necessary parts. The glass may be frosted to a pure white, and the wooden parts finished in glossy black enamel and silver paint.

All the articles illustrated were turned from soft pine. The lights have channels drilled for silk-covered lamp cord, and the cord leaves the bases through lamp-cord bushings. The candlelight is illuminated with a 3.2-volt pilot light, which is used in series with a 600-ohm, 5-watt resistor. The radio light uses a 15-watt frosted lamp.

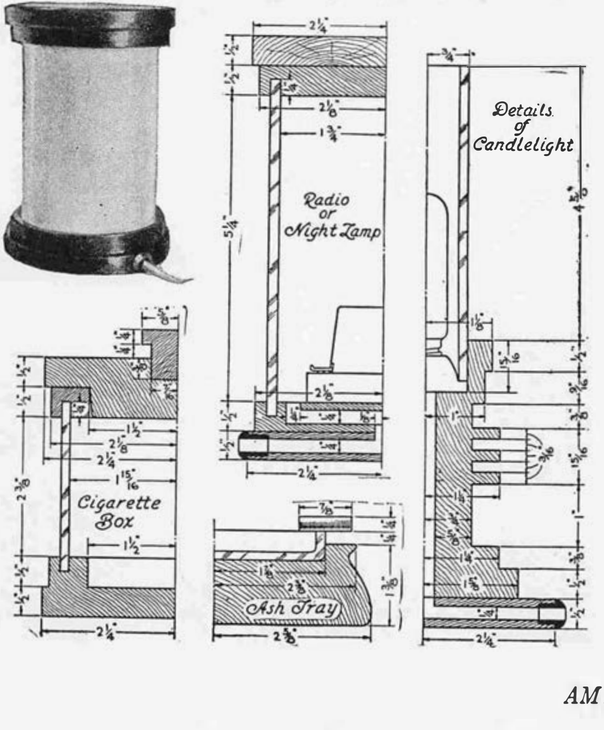
The glass tube for the candlelight is a medicine container, the top of which may be removed by filing or on a power grinder. It is frosted by grinding with emery and water in the manner shown. The glass for the radio light and the cigarette box are from large bottles. The tops and bottoms of bottles may be removed by filing.

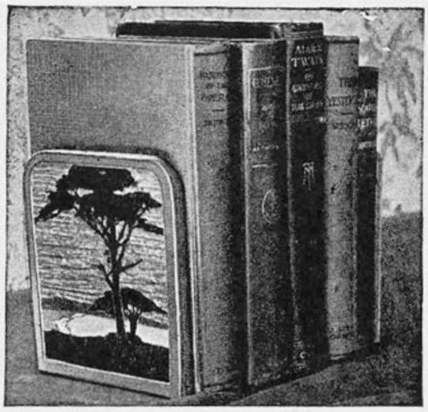


How the edges of the glass ash tray are ground; above, the complete tray

A radio or night lamp is shown at the right, and a cigarette box below, both made from bottles that have been frosted white

At the right are given the drawings for all four pieces. Note that the dimensions for width are to the center line





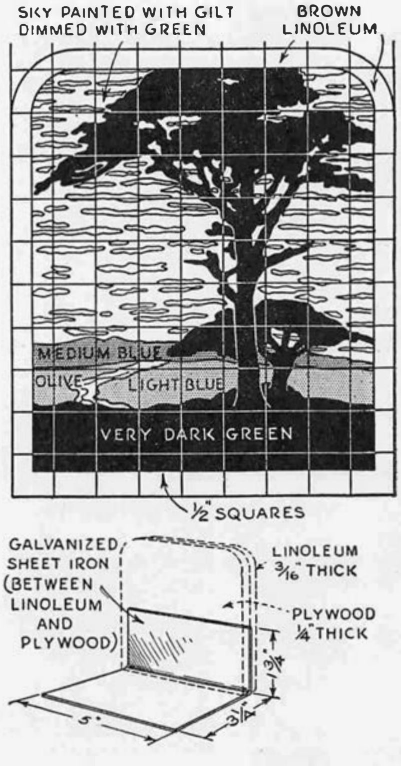
These neat, light book ends are faced with ordinary brown linoleum, carved and painted

LINOLEUM BLOCKS FORM COLORFUL BOOK ENDS

PAINTED linoleum cuts, when properly mounted, form colorful and attractive book ends.

Copy the drawing full size by sketching through ½-in. squares, and trace the pattern on brown linoleum 3/16 in. thick. Outline with a small gouge or V-tool, and gouge out the spaces between the sky lines, making no attempt to smooth the cuts. Now snip a rectangle of heavy galvanized iron and bend it at right angles to hold the book end upright. Cut out the linoleum and a piece of ¼-in. threeply wood the same shape, for backing, and glue the two together with linoleum cement, placing the upright leg of the iron between.

When dry, finish the piece as indicated. Paint the iron brown to match the linoleum, and glue a piece of green felt on the underside.



Pattern for laying out, gouging, and coloring the linoleum, and method of mounting it

Luggage Making
ON THE KITCHEN TABLE

How to construct high-grade pigskin-covered carrying cases for your own special purposes

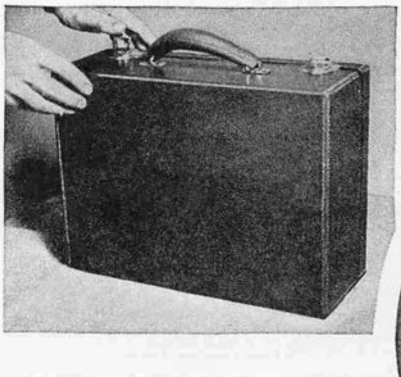
Without any special equipment or previous practice in leather work, you can make overnight cases and other fine, durable luggage

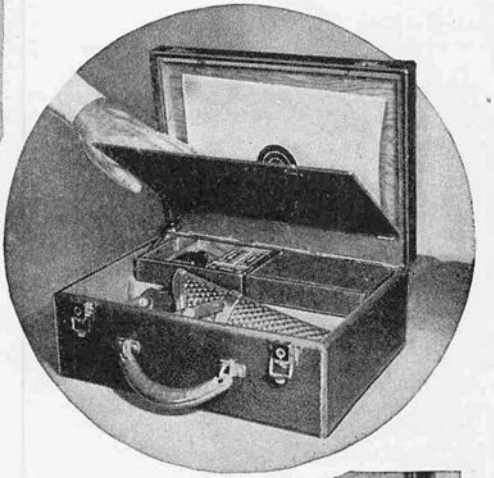
IF YOU need a durable, fine-looking, leather-covered carrying case for any special purpose, you can construct it yourself—on the kitchen table, if necessary—at a far lower cost than it would be possible to have an equally high-class piece of luggage made to order. For example, the case illustrated was constructed to carry three or four pistols and revolvers in their holsters for match shooting, together with all necessary accessories. The same principles of construction could be applied to any similar type of case, whether used for models, tools, samples, instruments, sporting squipment, games, or any especially prized possessions. An excellent overnight case could be made in this way.

While the appearance of the finished case, which weighs 4¼ lb., is in general similar to that of a handsome pigskin-covered dressing case, the construction is more rugged and better designed to keep the contents dry in a heavy rainstorm. The estimates of various luggage and leather goods shops for a similar specially made article ranged from $35 to $65. The case illustrated cost $8.16. Actually two cases were made—one for a friend—so as to use up a whole pigskin. Since that time prices have fallen, so you will not have to pay as much as the following figures:

Plain russet pigskin, 18¾ sq. ft. at 45 cents, $8.44; plain russet sheep skiver (split sheepskin), 13 sq. ft. at 8 cents, for lining, $1.04; 4 snap locks, nickel plated, $2.24; 2 russet handles with clips, $2; 4 pair No. 1 broad hinges, 6 cents; 10 brass ball feet, 10 cents; 1 reel pure linen sewing twine, 20 cents; 1 ball russet-colored shoemaker's wax, 5 cents; 1 can best-grade liquid glue, $1; 1 lb. ⅝-in. No. 17 F. H. wire nails, 18 cents; assorted split rivets, 10 cents; 15 sq. ft. ¼-in. three-ply fir at 6 cents, 90 cents; total for two cases, $16.31.

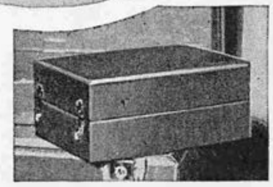
The whole job was done on the kitchen table with a small handsaw, light hammer, heavy hammer, screw driver, awl, try-square, hand drill, rule, straightedge, leather knife, and leather burnisher.





A pigskin-covered case designed to hold target pistols and accessories weighing 20 lb. *At right:* The case opened to show target compartment and tray

The foundation, a complete box, was made from ¼-in. three-ply fir. All joints were solidly glued as well as nailed. The case was provided with a compartment in the lid for targets and a folding tray for tools and small accessories. No detailed description of these is given, as they were included to serve a special purpose. One feature, however, may be of interest. The tray, which is leather covered, was hinged at the center and equipped with clasps so that it can be folded over and used as a separate small carrying case. An adaptation of this idea might well serve for other purposes—for example, a man's toilet kit in a suitcase.



The tray, also leather - covered, is hinged at the center and fitted with clasps so that it can be used separately as a small container

The side to which the handle is attached will be referred to as the front, and the opposite side (the hinged side) as the back; the large surface of the lid will be called the top, and the opposite side the bottom; the other two surfaces are the ends.

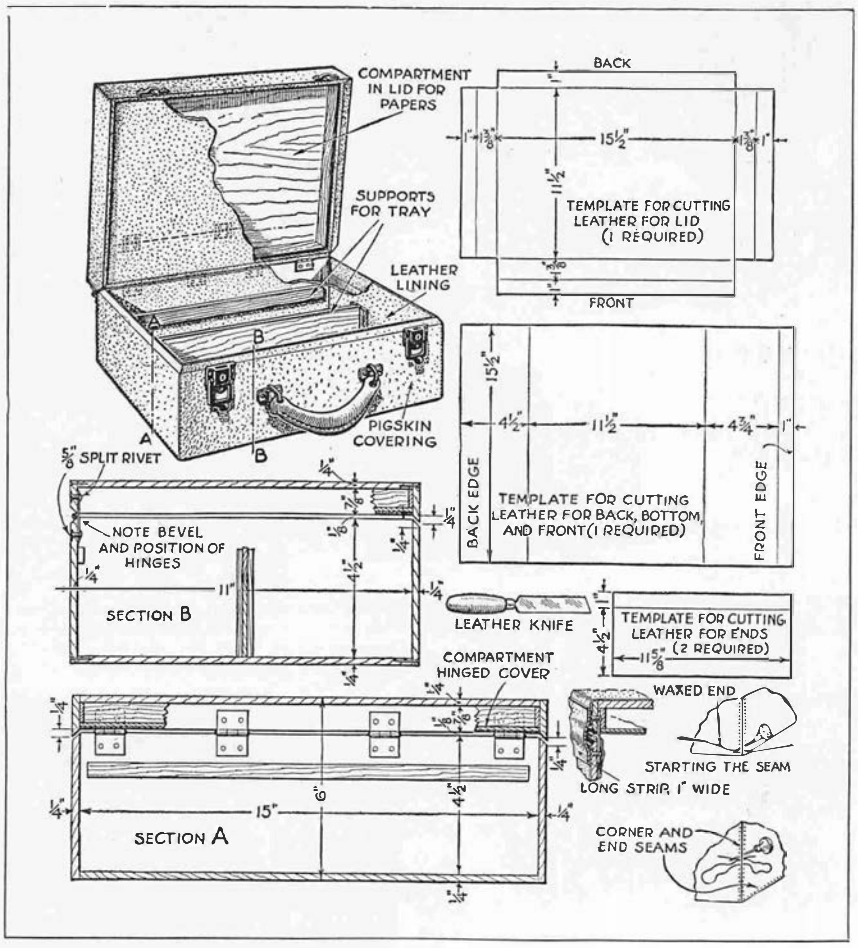
NOTE that the ends and front pieces of both body and lid are beveled on the edges where lid and body meet and that a space approximately ⅛ in. wide is left between the lid and body when the hinges are attached, to allow for the thickness of the leather. With well-fitted snap locks, the leather covering is compressed tightly enough to prevent moisture entering even in a rather heavy rainstorm.

The hinges are put on reversed from their normal position so they will not require countersinking, which would weaken the case. It is necessary to bevel the back-piece to slightly more than a 45-deg. angle to allow the lid to open. The hinges must be broad enough to allow the rivet holes to clear the bevel. Split rivets are used to attach the hinges and other parts.

When the foundation case is completed and the glue firmly set, you are ready to apply the leather covering. Keep the bench covered with clean wrapping paper; keep your hands clean; and do every part of the work with particular care.

Lay out and cut four templates as shown, modifying the dimensions, of course, in accordance with your particular job. Try the templates on the box. If they fit, lay the pigskin on the bench with the grain (hair) side up and select the part with the most attractive grain for the top.

Having determined the proper distribution of the leather, mark off the outlines of the templates on the hide and cut out the piece for the top. The best type of knife to use is that which leather workers employ almost universally. The least dullness will result in a ragged leather edge. The bevel must be equal on both sides of the blade; any inequality will cause the



knife to drift off the cutting line. Hold the knife against the straightedge in a plane perpendicular to the surface of the leather and inclined about 45 deg. in the direction of the cut. Make the complete cut without lifting the knife.

With the toppiece cut out, try it on the case. Heat the glue until it is fluid if this is required by the directions on the can. Place the cut-out leather in lukewarm water for a few seconds until the uniform darkening of the color indicates that it is soaked through. Allow it to drain while you apply the glue.

Beginning at the back, apply the glue with a brush in a thin coat to an area extending entirely across the top of the case and about half the width from front to back. Covering too great an area at one time will allow the glue to set partially.

Lay the leather in place, being careful to register it exactly at the edges and corners, and smooth it into place, working principally in the direction in which the glue was applied and forcing the excess glue from underneath toward the edges. Apply the glue to the remainder of the top surface and smooth the leather down.

NOW glue the leather on the back, ends, and front as far down as the edge where the lid meets the body of the case. If you have cut the leather carefully, the edges will meet and butt together at the corners to make a neat, square joint.

Let the glue set firmly (a matter of a few minutes with the type which has to be heated) and then trim the edges to the proper angle to turn over into the inside of the case. Be careful to make the corners fit up closely where they turn over the edge of the wood. Glue the edges in place on the edge of the wood and inside.

The leather covering for the body of the case is now cut and applied in the same way. The large piece covering the back, bottom, and front should be applied first, and the ends afterward. In the back, both the body and lid covering should come just to the edge of the hinge bevel and should not turn into it.

WHEN the glue has firmly set all over, it is time for the sewing. The materials required are an awl, russet-colored shoemaker's wax, and linen sewing twine somewhat smaller in diameter than the twine that is used for tying up laundry. The twine must be of pure linen.

To prepare the twine for sewing, take a suitable length for the seam to be sewed and, holding it about 3 in. from the end, lay the end down on a narrow strip of wood. With the square back of the knife, scrape from a point some 2 in. from the end toward the end to taper the end. Treat the other end in the same way. Then, holding a piece of wax between thumb and finger, draw the twine from the middle toward the ends successively until the whole length is covered with wax. Hold the twine 6 in. from the end and roll the end with the other hand on the bench until it is smooth, round, and tightly twisted. This twisted and waxed end will enter an awl hole readily.

It will be well to sew a practice seam before starting on the case itself. Nail two pieces of scrap plywood together at right angles and cut from the hide sufficient leather to cover each of them for a distance of a couple of inches back from the corner. Glue the leather in place. Lay off a line on each side of the corner, parallel with the edge and 1/4 in. from it. On this line, prick off with the dividers a series of points 3/16 in. apart.

STARTING at the mark nearest one end of the practice seam, push the awl through diagonally, penetrating the wood and the leather on both sides of the corner. Be careful that the awl comes out on the opposite divider mark. Withdraw the awl and push it through from the other side to make the hole of uniform diameter throughout. Thread one end of the waxed twine through the hole and pull it through until it is centered in the hole. Push the awl through at the next point from both sides. Now, taking one waxed end of the twine in each hand, push the two ends simultaneously through the hole from their respective sides, so that they cross inside the hole. Take hold of the ends and pull them through, putting enough tension on the twine to set the stitch firmly into the leather. Continue stitching in this way until you are making the stitches uniform in length and parallel to the corner.

Now stitch up the corners of the case in the same way. It is better to stop each seam where the leather turns over to enter the case, as it will be almost impossible to make a neat seam around the corner.

Heat the burnisher, or any smoothly polished piece of steel with rounded corners until it emits a snapping sound when the moistened finger is touched to it. Holding the surface of the steel across the corner, rub it up and down along the edges of the leather. This will bring the edges together and darken them slightly.

The hardware should now be applied. The handle will probably be equipped with D-rings which pass through stamped clips that are to be riveted to the front of the case. If the case is to carry a heavy weight, it will be well to prepare a steel plate of 1/16- or 3/32-in. metal large enough to extend from clip to clip on the inside and with holes drilled to take solid —not split—rivets, and to rivet through the plate as well as the wood.

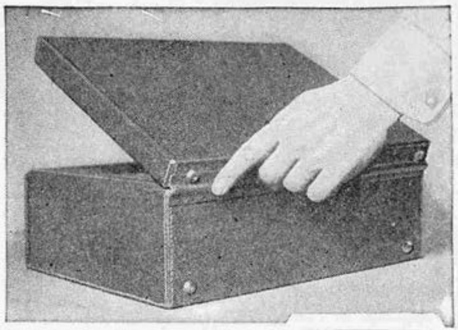
THE snap lock consists of two parts. Snap these together and lay them on the case in the locations they are to occupy. Mark the rivet holes of the larger part and drill holes through leather and wood of the same size as the holes in the lock plate. Use split rivets of a size that will snugly fill the holes; they should be long enough to extend inside the case about 3/16 in.

Close the case again and, with the small parts of the locks engaged with the larger, press the lid of the case down hard, at the same time pulling the small parts of the locks away from the larger until all lost motion is taken up. Then mark the rivet holes and rivet securely.

To avoid excessive wear on the back of the case when it is set down, ball feet should be attached near the corners.

Select a part of your pigskin from along the belly edge where the leather is soft and spongy and cut out a piece about 1 in. wide and long enough to extend from end to end of the slot at the hinged back of the case where the wood is beveled. With the case closed and the locks fastened, cement this strip smoothly over the slot. It will be well to scrape the grain surface of the leather with a knife where the glue is to be applied to remove the impervious surface.

AFTER the glue has set firmly, open the lid a little and see if the covering strip bulges out neatly. If it tends to bend inward instead, slip a slender rod under it from one end and force it gently out as you open the lid. As soon as the whole length has begun to bend outward, remove the rod and open the case wide. The next time you open it, the strip will have taken a permanent set.



The hinged joint is covered with a narrow strip of soft, spongy leather. *At right:* A corner seam

Cut a piece of the lining leather the exact size of the bottom inside and cement it smoothly in place. Treat the inside of the top in the same manner.

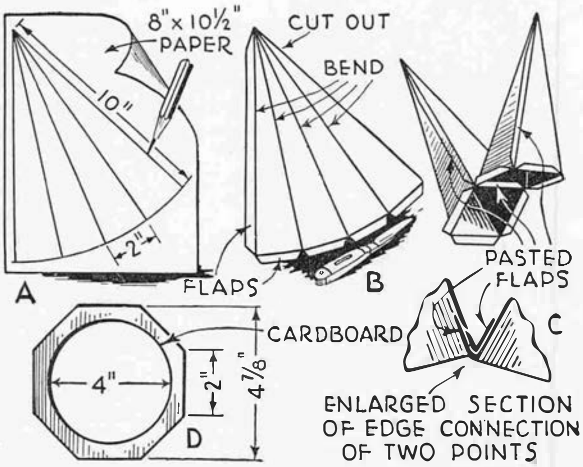
Cut pieces of cardboard of approximately the same thickness as the covering leather and of the proper size and shape to fill the area on the ends, front, and back between the edges of the covering leather where it is glued inside the case and the bottom. Cut openings in these pieces to clear the hinges and the rivet plate or burrs where the handle is attached, and glue them in place.

Cut other pieces of cardboard of the same size as the ends, front, and back and cover them smoothly with the lining leather, carrying the leather over the edges and cementing it on. Cement these covered pieces in place, and the entire job is done.

Give the completed case from twenty-four to forty-eight hours to dry out thoroughly. The outside pigskin should now have come back to its original very light russet color. If it has been heavily dressed, you may find that it is stained in spots. Should this be the case, scrub it all over with clear water and then with a good saddle soap. When it dries after this treatment, the water stains will be found to have disappeared.

The natural light color of the pigskin, while attractive, is easily soiled, and you will probably find it desirable to darken it somewhat. This may be done by repeated applications of saddle soap or, if a still darker color is desired, by the judicious application of neat's-foot oil. To keep the case in good condition, give it a heavy application of saddle soap from time to time.

ILLUMINATED *Christmas Star* MADE FROM PAPER



Folded paper star with an electric lamp inside; and, at right, how the individual points are made, and a pattern for the two frames

A MANY-POINTED Christmas star, illuminated inside, can be made from twenty-six sheets of heavy white paper, such as 8 by 10½ in. typewriting paper; a bakelite electric light socket of the kind without a switch, costing ten cents; a 25-watt lamp, several feet of lamp cord, and a plug for the cord.

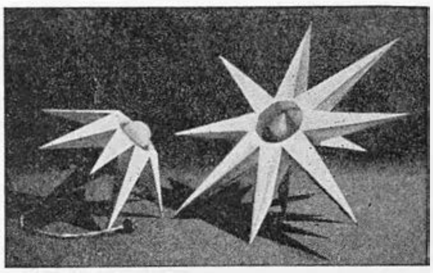
Lay out and cut a sheet of the paper as shown at *A* and *B*, with tabs about ¼ in. wide on one side and on the bottom of each triangle. Using a straightedge, fold the paper on the four long lines. Then turn it over and fold the four bottom tabs back. Now paste the long side tab to the opposite side to form a pyramid, which is a complete point for the star. Eighteen of these four-sided points are required.

Next make eight points with only three sides. These are the same as the four-sided points except that one of the sides is left off.

The points are fastened together by pasting a bottom tab to the outside of an adjacent point, and then pasting the tab of that side inside of the first point, as shown at *C*. Fasten a four-sided point to each side of a four-sided point to form a cross, and then fasten a three-sided point in each of the four angles of the cross. Make two of these groups. Finally, fasten the remaining eight four-sided points to one of the above groups so as to form a complete circle.

From a sheet of medium cardboard cut out two octagons as shown at *D*. Paste one of these into each of the groups of points, using the remaining tabs.

Splice several feet of lamp cord to the lamp socket, taping the joint well. Open up the tip of the central point of the smaller group of points, and push the wire through from the bottom. Draw the socket up into the point until the lamp hangs about in the middle of the star; then fasten the tip of the point firmly to the wire with adhesive tape or paste and paper, as this forms the only support of the star. Put the plug on the other end of the wire, and make sure that the lamp will burn in the socket. Hang the group of points up and have someone hold the larger group against the smaller while you tie them together by passing a long piece of white grocery cord around the star about four times in as many different directions.



The sections before being tied together. In this case the points are of various lengths

This type of star may be varied in many ways. For instance, the star in the photographs was made by using points of different lengths. Also, colored paper or a colored bulb might be used.

RAZOR HONE GIVES KEEN EDGE TO FINE WOODWORKING TOOLS

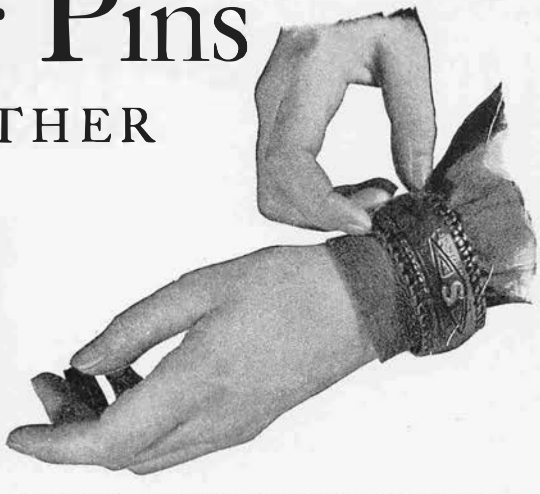
A TEN-CENT razor hone, which is nothing more than a very fine oilstone, will prove a valuable aid to the man who likes to give his woodworking tools the keenest possible edge. Sharpen the tools in the regular way, then given them a few strokes on the razor hone. This gives a razor-sharp, long-lasting edge suitable for the finest kinds of work.

The same type of razor hone can be made into handy little slip stones of special shapes, such as are needed for sharpening gouges, wood-carving tools, and the like. Just break the stone to an approximation of the desired shape, and bring it to final form on an ordinary bench grinder.

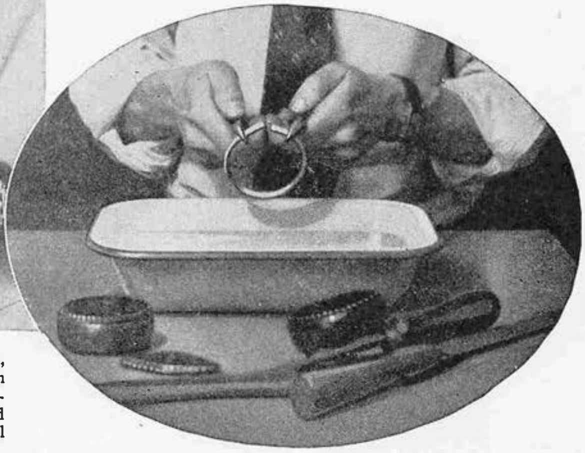
Bracelets *and* Bar Pins

OF HAND-TOOLED LEATHER

Leather-covered bar pin with tooled initial and ornament. The edges are neatly laced



A celluloid insert within the bracelet gives it the required springiness. Note the perfection of the lacing



After the bracelet is assembled, lacing holes are punched through the bottom piece of leather as illustrated above. The way to bend the celluloid is shown in the oval

ATTRACTIVE hand-tooled leather bracelets and bar pins require but little time and expense to make. They are durable, light in weight, and can be prepared in a variety of colors to match any shade of wearing apparel. Two-tone effects are obtained, if desired, by using contrasting colors of lace and painting the initials or monograms with leather lacquer. Well-made costume pieces of this kind find a ready sale because of their novelty and individuality.

The materials for a bracelet are: 1 pc. tooling calf 1 by 7⅛ in. and 1 pc. 1 by 6¼ in.; a strip of celluloid ⅛ by ⅝ by 6⅜ in.; 1 pc. felt or leather suède for padding, ⅜ by 6½ in.; and 7 ft. of 3/32-in. thong lacing for the loop stitch.

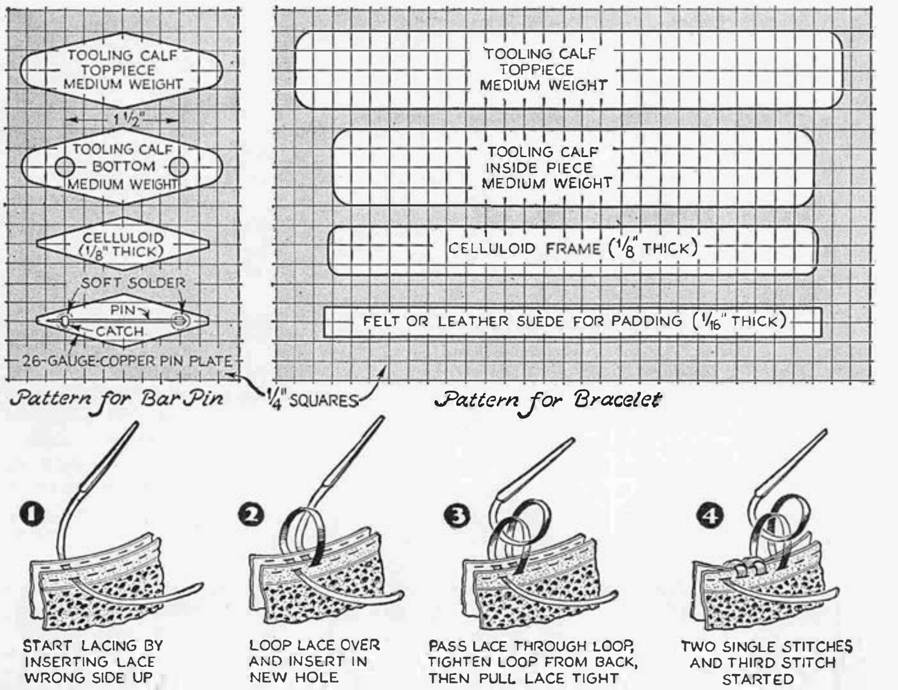
The first step is to sketch a simple design and initial or monogram on a piece of paper the same size as the upper or longer piece of tooling leather, allowing a ⅛-in. margin for the thong lacing. (You will save considerable time by using dividers to scribe guide lines on the leather for the lacing and borders.) After the leather has been dampened with a sponge or wad of cotton soaked in water, place it on a smooth hardwood surface and secure both the leather and the design sheet by means of thumb tacks at all four corners. Keep the thumb tacks close to the corners so the marks will not show on the finished work.

Transfer the design onto the leather by using a tracer or modeling tool. Keep the tool in a slanting position and work toward you, pressing lightly. Use a straightedge, if necessary, to guide the tool when following the straight lines. When the tracing is completed, remove the design sheet and go over the outline on the leather with the tracer or modeling tool. Press firmly until the design is embedded deep enough to stay. Keep the leather moist (not too wet) until the tooling is completed. The corners can then be rounded off by using a round metal disk as a guide for the knife. (Do not assemble the parts until the leather is dry, as leather will stretch out of shape when wet.)

Punch the tooled piece of leather with a single thong punch, making the holes ⅛ in. from the edge and about the same distance apart. The inside or shorter piece of leather is punched just before lacing.

Before bending the celluloid strip, file the corners round and bevel the top edges. Then place it in a pan of boiling water and with the aid of pliers, form it into a bracelet shape, as illustrated. When bending, make sure the beveled edges are on the outside of the strip facing you. After it has cooled, the celluloid frame will have a springlike tension, making it easy to slip on and off the wrist.

Cement the parts together, punch the inside piece, and lace as shown at the left. The bar pin is made in a similar manner.

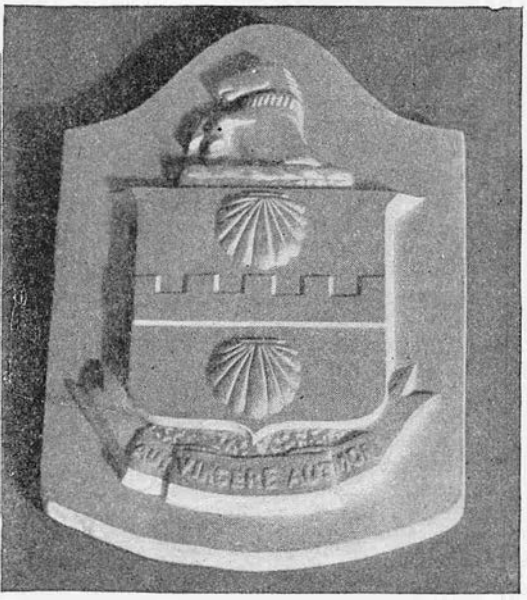


TOOLING CALF
TOPPIECE
MEDIUM WEIGHT
1½"
TOOLING CALF
BOTTOM
MEDIUM WEIGHT
CELLULOID
(⅛" THICK)
SOFT SOLDER
PIN
CATCH
26-GAUGE COPPER PIN PLATE
TOOLING CALF
TOPPIECE
MEDIUM WEIGHT
TOOLING CALF
INSIDE PIECE
MEDIUM WEIGHT
CELLULOID FRAME (⅛" THICK)
FELT OR LEATHER SUÈDE FOR PADDING (1/16" THICK)
¼" SQUARES
Pattern for Bar Pin
Pattern for Bracelet
1
2
3
4
START LACING BY INSERTING LACE WRONG SIDE UP
LOOP LACE OVER AND INSERT IN NEW HOLE
PASS LACE THROUGH LOOP, TIGHTEN LOOP FROM BACK, THEN PULL LACE TIGHT
TWO SINGLE STITCHES AND THIRD STITCH STARTED

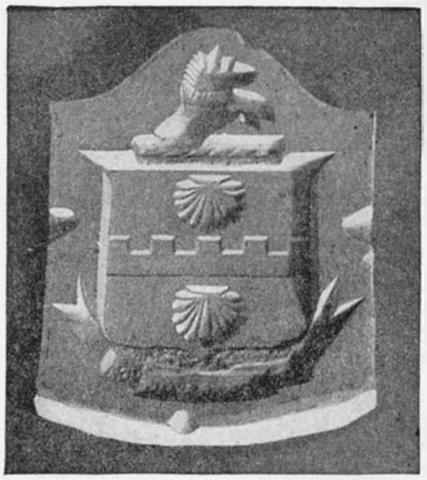
How to lay out the various parts of the bar pin and bracelet, and steps in making loop-stitch lacing

CASTING
Plaster Ornaments

A new hobby that can be made to pay cash dividends



Decorative plaster-of-Paris medallion of heraldic design. Many such ornaments can be cast in a single plaster mold



The plaster mold. The finger notches are filled with wax before making the final cast

MAKING decorative plaster casts is a hobby that is not only interesting, but can easily be made profitable. There is a market for the finished product, and a good chance for profit because the actual cost of each article is low. Among the projects that can be made are coats of arms, medallions, book ends, and wall plaques of many designs.

The equipment you'll need is as follows: 1 lb. or more of nonhardening modeling clay, generally called plastine or plasticine; 1 lb. dental or casting plaster of Paris; 1 smooth board 12 by 12 in.; 1 jar vaseline; and a camel's-hair brush, palette knife, cuticle knife, orange stick, mixing bowl, and tablespoon.

A sketch of the coat of arms, or other article to be made, must first be drawn, preferably the size desired for the finished product. Then spread about ½ lb. of the clay over a smooth board in a perfectly smooth layer about ⅜ in. thick. The edges should be trimmed to form the shape desired, such as a square, rectangle, circle, oval, or shield, according to the general dimensions of the piece to be made.

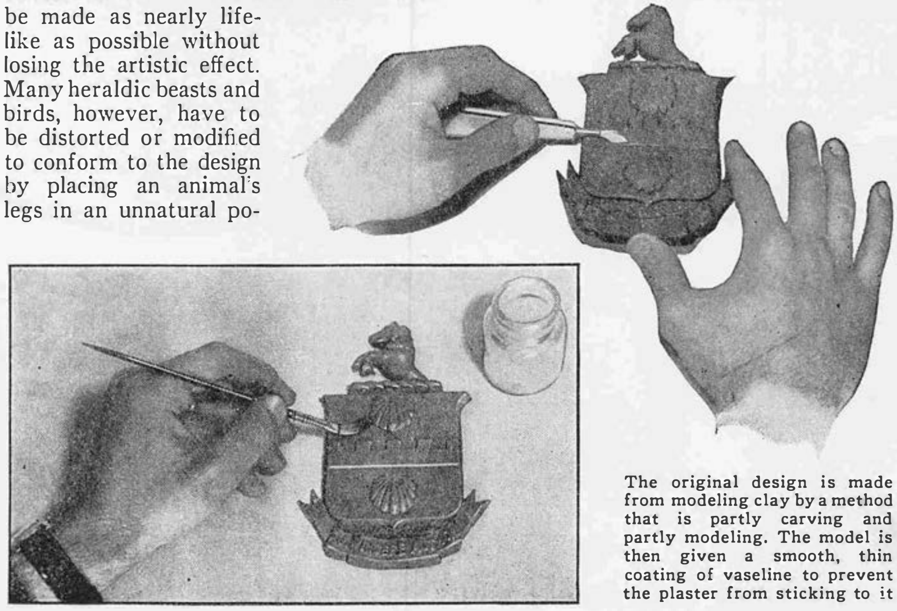
Using the orange stick (or a pencil), draw every line of the design on the surface of the clay very lightly. Use the cuticle knife to cut this design out, holding the knife at an angle of about 50 deg. so that the edge slants *away* from the design. This is important in order to eliminate any drag when the cast is made, as will be explained later. Only cut a small piece at a time as the clay has a tendency to tear if too large a piece is cut.

There will be several places that will have to be built up or cut down according to the design. For example, if there is a fess or bar across the shield in a coat of arms, it should be cut out of another strip of clay about ⅛ in. thick and placed on the shield in the desired position. In the same manner stars, roses, lions, fleurs-de-lis, and the like must be cut out separately and placed on the shield. In the crest (meaning everything above the shield), the helmet with its crest and mantling should be so carved as to represent one half the article as worn in real life. In some cases it will be a front view and in others, a side view. This is also true in the case of animals, birds, or other figures, whether used in the crest, in the shield, or as supporters on each side of the shield. Heraldic animals and birds should be made as nearly lifelike as possible without losing the artistic effect. Many heraldic beasts and birds, however, have to be distorted or modified to conform to the design by placing an animal's legs in an unnatural position or lengthening the tails of animals or wings of birds.

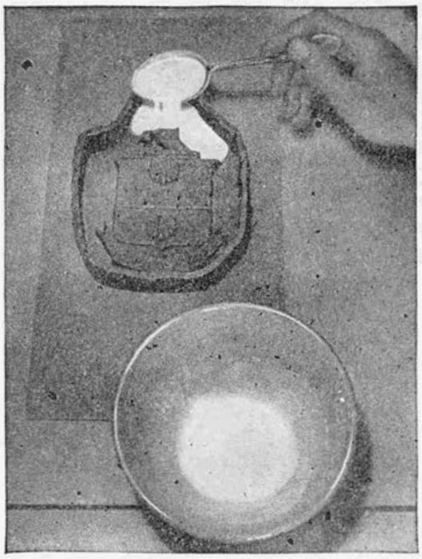
If there is a motto with the arms, the scroll in which it is inscribed should be carved so as to look wavy, as it would if it were a piece of ribbon.

When the clay model has been cut out, it should be made perfectly smooth all over. The simplest way to do this is to moisten the finger tip and run it lightly over the surface. When it is smooth, take a camel's-hair brush and paint the entire piece with vaseline, being careful to see that the vaseline also is smooth and covers the entire surface as well as a good portion of the board. This is to prevent the plaster of Paris from sticking to the model. Now a wall about ¼ in. thick and 1½ in. high must be set up around the whole model. This can be made of clay. Leave about ¾ in. between the model and the wall. Paint the inside of the wall with vaseline.

Put about 5 oz. of plaster of Paris into a bowl and add enough water to give a consistency like gruel—just thin enough to pour out of the spoon. This mixture should be stirred until the plaster of Paris and the water are thoroughly mixed and there are no lumps. Pour this into the mold, using the spoon and letting the mixture drip off rather slowly. It is best to start in one corner and gradually work away from it, as this will force all air ahead and there-



The original design is made from modeling clay by a method that is partly carving and partly modeling. The model is then given a smooth, thin coating of vaseline to prevent the plaster from sticking to it



A wall of clay is set up around the model, and thin plaster poured in to make the mold

fore prevent bubbles from forming underneath. Be sure the mixture gets into every crevice. This is accomplished by gently working it in with the back of the spoon.

When the entire surface has been covered, fill the rest of the mold to within about ½ in. of the top. In case you have not mixed enough plaster of Paris the first time, you can mix another batch, being careful not to wait too long. Clean the mixing bowl and spoon with running water as soon as possible.

Depending on the size of the model, it will take up to an hour for the cast to become hard enough to remove. When it has thoroughly set, remove the clay wall. To separate the cast from the model, first take hold of the cast and work it back and forth gently. This will help loosen it. Now take hold of it in two places firmly and pull *straight upward.*

When the cast is free, take the cuticle knife and trim off all rough spots while the plaster of Paris is still damp.

This intaglio or mold is allowed to dry. The best way to do this is to place it in the sun. The drying can also be done in a very slow oven, but this takes longer.

When it is finally dry and perfectly smooth, cut two notches in each side and one in each end, using the cuticle knife. Now place the cast on the board again and build a wall around it as before. The wall should rise about ½ in. above the top of the cast.

Take a lighted candle and drip wax into the notches. When the next cast is made, this wax is removed, and the notches become finger grips to enable you to separate the casts. Paint all surfaces of the intaglio, including the waxed notches, with vaseline. Now mix the plaster of Paris and proceed as before, filling the mold right up to the top. In about an hour, the clay wall may be removed and the wax taken out of the notches. Then take the cuticle knife and run it around between the two casts to loosen them a bit. Separate the two, using a firm and steady pull, straight up. If all drag was eliminated in the original model, this will be easy.

The final cast just made is the bas-relief. It should be trimmed and smoothed with the cuticle knife and very fine sandpaper.

It it is desired to hang the bas-relief on a wall, a wire hanger should be set in the center of the back near the top, just after the plaster of Paris has been poured.

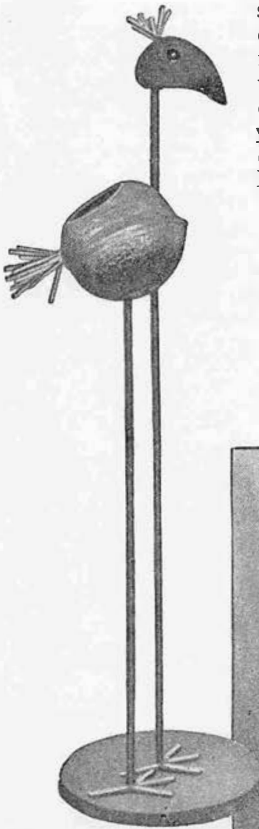
These make attractive ornaments when colored. This may be done by giving the cast about four coats of shellac and then painting it with the desired colors in enamel.

AIR PRESSURE CLEANS TYPEWRITERS QUICKLY

An air compressor is one of the most effective devices for cleaning a typewriter in a schoolroom, office, or home. Use a bent brass nozzle about 6 in. long, ½ in. in diameter, and with an opening of about ¼ in., and apply a pressure of from 35 to 40 lb. of air. By blowing this through both the top and the bottom of the machine, a very thorough job can be done. Not only every bit of erasure material and dust is blown out, but any excess oil is atomized and distributed more evenly throughout the machine.

This method has been tried on forty-five typewriters in one school, and has worked miracles with machines that had become not only clogged, but sticky in various working parts.

COMICAL COCONUT BIRD SERVES AS ASH TRAY



You could hunt in vain through the jungle to find a mate for this curious bird. He doesn't fly and has no song, but he has a real purpose nevertheless—to hold cigarette butts and ashes

This funny-looking long-legged tropical bird is one of the best smile-provokers you could have. It also serves as an ash tray.

Take off the outer husk of a coconut and wire-brush the shell. Saw a slice off the top of the nut to make the large opening, and drill the three leg and neck holes to fit the legs, which are ⅜-in. dowels, so they will be very tight. No glue is used. The longest piece, which is 30 in., serves as the neck as well as one leg. The short dowel is 25½ in. long.

The base is 8½ in. in diameter and 1 in. thick. One hole is drilled in the center and the other 2 in. from the edge. The feet are eight pieces of ¼-in. doweling cut 1¾ in. long and fastened to the base with ½-in. No. 20 brads. Drive the legs into the base before fastening the feet. The longest one goes in the center of the base.

The head is cut out of a piece of scrap wood from 1 to 1¾ in. thick. Bore two ⅜-in. holes in the head, one for the topknot and the other for the neck. The topknot consists of four pipe cleaners cut in half and doubled; the tail is made from ten or more cleaners bent double, pushed in the hole in the end of the nut, and wrapped with an extra cleaner inside the nut.

An orange head and body trimmed with black, a red topknot and tail, black legs, knee joints indicated with a touch of orange, black feet with orange nails on a green base mottled with orange—this color scheme makes an attractive bird.

After the enamel or lacquer is dry, put some sand in the shell for smothering cigarettes, and your "Gogo-bird" is ready to take his appointed place.

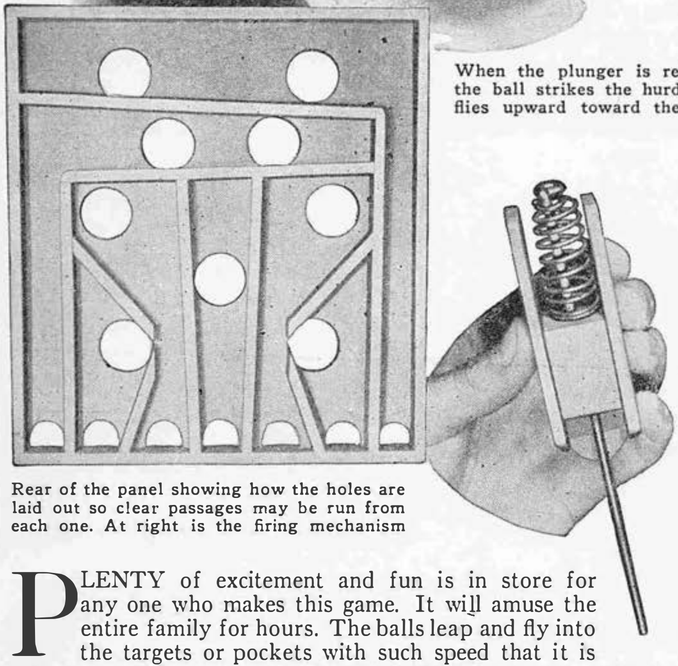
All you need to make the bird besides the coconut are two sizes of wooden dowels, scraps of wood for the base and head, pipe cleaners, and orange, black and green enamels

GAMES and TOYS

Flying Ball...

AN EXCITING NEW MARBLE GAME ANY ONE CAN MAKE

When the plunger is released, the ball strikes the hurdle and flies upward toward the holes



Rear of the panel showing how the holes are laid out so clear passages may be run from each one. At right is the firing mechanism

PLENTY of excitement and fun is in store for any one who makes this game. It will amuse the entire family for hours. The balls leap and fly into the targets or pockets with such speed that it is often impossible to see exactly where they have gone until they drop out of the holes at the bottom and into the scoring pockets.

The box and cover are each about 10 by 12 in. and 1½ in. deep. The bottom and the outside covering of the top can be made from heavy cardboard. The inside panel of the top should be made from light plywood, pressed composition wood, or ¼-in. pine. The holes that serve as pockets for the balls as they are shot are bored or cut 1¼ in. in diameter.

By referring to the photograph that shows the layout from the back, you will see that the holes must be carefully located so that the channels can be placed without interference. These channels are made from ¼-in. wood and should be at least ⅛ in. wider than the diameter of the balls used.

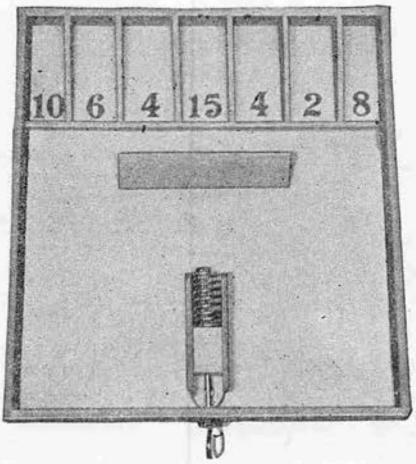
In the model shown, ½-in. agate marbles were used for balls, and the channels were made ¾ in. wide. Place a small wedge-shaped bit of wood at the bottom of each channel so that when the balls fall down the channel they will land on the wedge and be ejected into the scoring pockets. The holes at the bottom of the panel should be just large enough to pass the balls freely. The scoring pockets are spaced so as to correspond with these openings.

Place scoring numbers in the pockets. An old calendar will furnish the numbers. The highest pockets are the easiest ones in which to place the balls, so they should be given the lower scoring numbers. The highest number should be placed on the lowest central hole. The balls travel the shortest distance when shot at this hole, and it requires some judgment to shoot them with just enough force to score here.

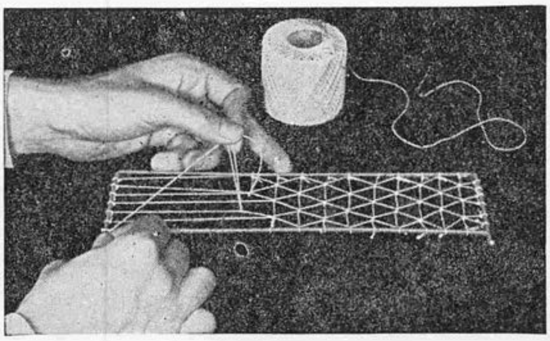
The firing mechanism is constructed from three pieces of wood and a piece of wire coat hanger or other heavy wire for the plunger. The spring for the model was made from half of a spring from an old electric flatiron cord, but a suitable spring can be purchased from your hardware dealer for a few cents.

Form a tight loop at one end of the plunger and bend the loop at right angles to the wire to form a surface to strike the balls. The other end of the plunger passes through a ¼-in. hole in the side of the box nearest the player, therefore the ring for a finger grip should not be formed until the firing mechanism has been assembled in place.

The "gun" is located centrally in the bottom of the box and is fastened to the bottom with one wood screw so that the



The completed base unit, shown at the left, has seven scoring pockets into which the balls return



In making the net, fasten the lengthwise cords on first and leave them about 1 in. slack. Glue the end knots before cutting the cord mechanism can be moved or swung as necessary for the various shots. The ¼-in. hole in the side limits the travel and prevents the overanxious player from aiming at a point beyond the target.

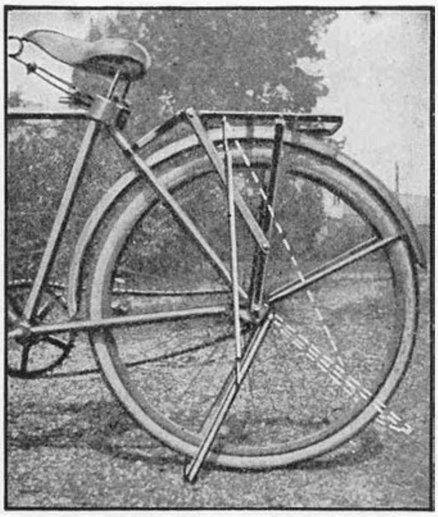
About midway in the bottom of the box, place the hurdle that the ball must strike and leap before it can reach the pockets. The hurdle is made from a 1-in. square block about 5 in. long. Plane a 45-deg. bevel on the block. The exact location of this hurdle with relation to the pockets should be determined after a few experimental shots at the targets, because the size of the spring used and the diameter or weight of the balls will influence its position. It should be placed so that the full force of the spring will easily carry the balls to the highest pockets.

The wire for the net at the top of the game can also be obtained from a coat hanger. This frame is not at all essential to the game, but occasionally while shooting at the highest pockets the ball will carom off the panel and into the room. The net will keep the balls in the game at all times. The net is made as wide as the game and 3 in. high. Its two legs go into two holes drilled in the top of the game.

A wire brace is provided to hold the cover upright. When you make the holes for this brace, be careful to drill into the edge of the panel so that the wire will not obstruct the passage of the ball.

Each player gets three chances at the target for each turn, and an extra turn for each ball placed in the pockets counting ten or fifteen.

SPRING SAVES STOOPING TO USE BICYCLE STAND

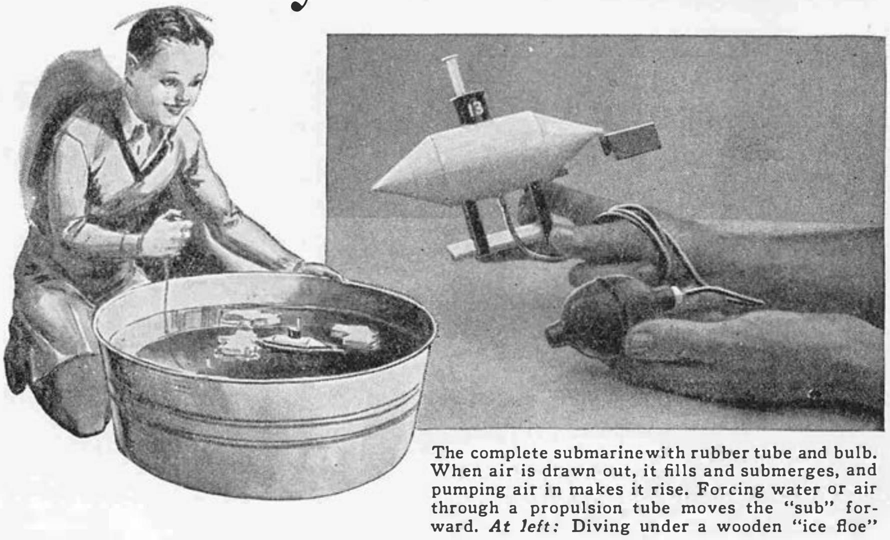


As the bicycle is pushed forward, the long spring lifts the stand to the dotted position

BY THE addition of a ten-cent screen-door spring, the ordinary type of bicycle stand can be made much more convenient to use. The spring is attached to the middle of the stand and the luggage carrier as shown. When the stand is to be let down, all that is necessary is to push it down with the foot instead of unhooking the stand from the catch on the fender by hand. To raise the stand again, the bicycle is merely pushed forward. The stand is then automatically pulled up into place and held by the spring in approximately the position shown by the dotted lines in the photo.

PRESSING A RUBBER BULB PROPELS THIS INGENIOUS

Toy Submarine



The complete submarine with rubber tube and bulb. When air is drawn out, it fills and submerges, and pumping air in makes it rise. Forcing water or air through a propulsion tube moves the "sub" forward. *At left:* Diving under a wooden "ice floe"

THIS amusing little submarine can be operated in an ordinary tub or a bathtub full of water. It will move forward on the surface, submerge, travel under the water, and rise again.

The hull is made from a small tin can about 2 in. in diameter and 3 in. long, with both ends removed. If such a can is not obtainable, you can make one from the tin of a larger can.

The cone-shaped ends, the conning tower, and the periscope are made as shown. The small tin tubes are formed around a nail of the proper size. The nail is then removed and the seam soldered. The 4-oz. lead weight is suspended 1 in. below the hull, otherwise the boat will be unstable.

The rubber tubing should be as small and light as possible (about ⅛ in. outside diameter) and 3 or 4 ft. long. Tubing such as that used on trick roses is very good. Novelty stores usually have them for sale. If one tube is too short, join two of them together. The bulb that is ordinarily attached to the tubes is rather small, but it may be used if a hole is cut in it. A bulb from an atomizer is better. The valve should be removed and the tubing attached as shown. Other details of construction are made clear in the drawings below.

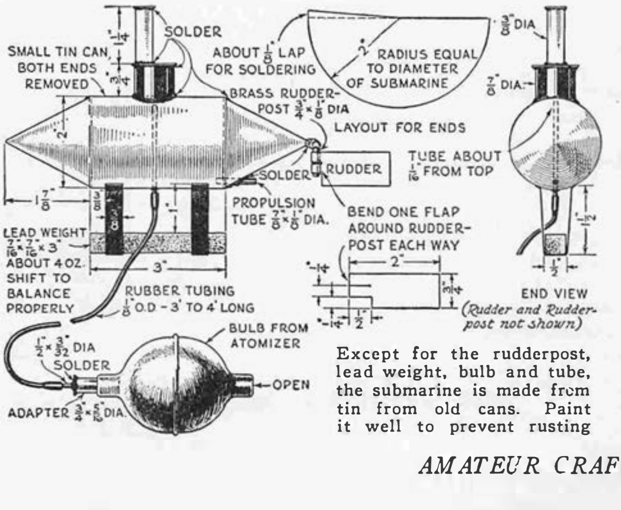
The tube on the submarine to which the rubber tubing is connected extends to the top of the hull, and the only other opening into the boat is the propulsion tube. Thus, to submerge, air is drawn out by means of the bulb and water enters through the propulsion tube at the stern. The vessel will settle lower and lower until finally the periscope goes under. If you wish, you may submerge until only the top of the periscope is in view.

To bring the submarine to the surface again, simply pump air in by squeezing the bulb while the thumb is held over its open end. Then, before releasing the bulb, remove the thumb, and before squeezing it again, replace the thumb. When drawing air out, the operation is reversed.

To propel the submarine forward on the surface, set the rudder as desired. Next, compress the bulb and draw air out of the boat until the deck is awash. Then press the bulb steadily. As water is forced out of the stern tube, the boat will rise and move forward at a fair rate of speed. Keep your thumb on the bulb opening and allow the bulb to expand; then repeat the operation.

The most interesting trick is to propel the boat forward without rising to the surface. In order to do this, submerge until resting on the bottom. Then force air into the boat until it just starts to rise and move forward, but release the pressure before it has had time to rise to the surface. Allow the boat to sink, and repeat the operation.

Paint some wooden blocks white, as shown in one of the illustrations, to represent an ice floe, and you can have a lot of fun trying to pass under the floe without bumping the periscope. If you come to a patch of open water, pump air in very slowly to bring the submarine straight up.


SOLDER
SMALL TIN CAN, BOTH ENDS REMOVED
1¼"
⅜"
ABOUT ⅛" LAP FOR SOLDERING
RADIUS EQUAL TO DIAMETER OF SUBMARINE
⅜" DIA
⅞" DIA
BRASS RUDDER-POST ¾"×⅛" DIA
LAYOUT FOR ENDS
2"
TUBE ABOUT 1/16" FROM TOP
SOLDER
RUDDER
1⅞"
⅜"
⅜"
1"
PROPULSION TUBE ⅞"×⅛" DIA.
BEND ONE FLAP AROUND RUDDER-POST EACH WAY
LEAD WEIGHT 7/16"×7/16"×3" ABOUT 4 OZ. SHIFT TO BALANCE PROPERLY
3"
2"
1¼"
⅜"
1½"
RUBBER TUBING ⅛" O.D - 3' TO 4' LONG
½"
1¼"
½"
END VIEW (Rudder and Rudder-post not shown)
BULB FROM ATOMIZER
½"×3/32" DIA
SOLDER
OPEN
ADAPTER ⅜"×⅝" DIA

Except for the rudderpost, lead weight, bulb and tube, the submarine is made from tin from old cans. Paint it well to prevent rusting

NEW Auto-Driving Game

TESTS YOUR SKILL AT HIGH-SPEED STEERING

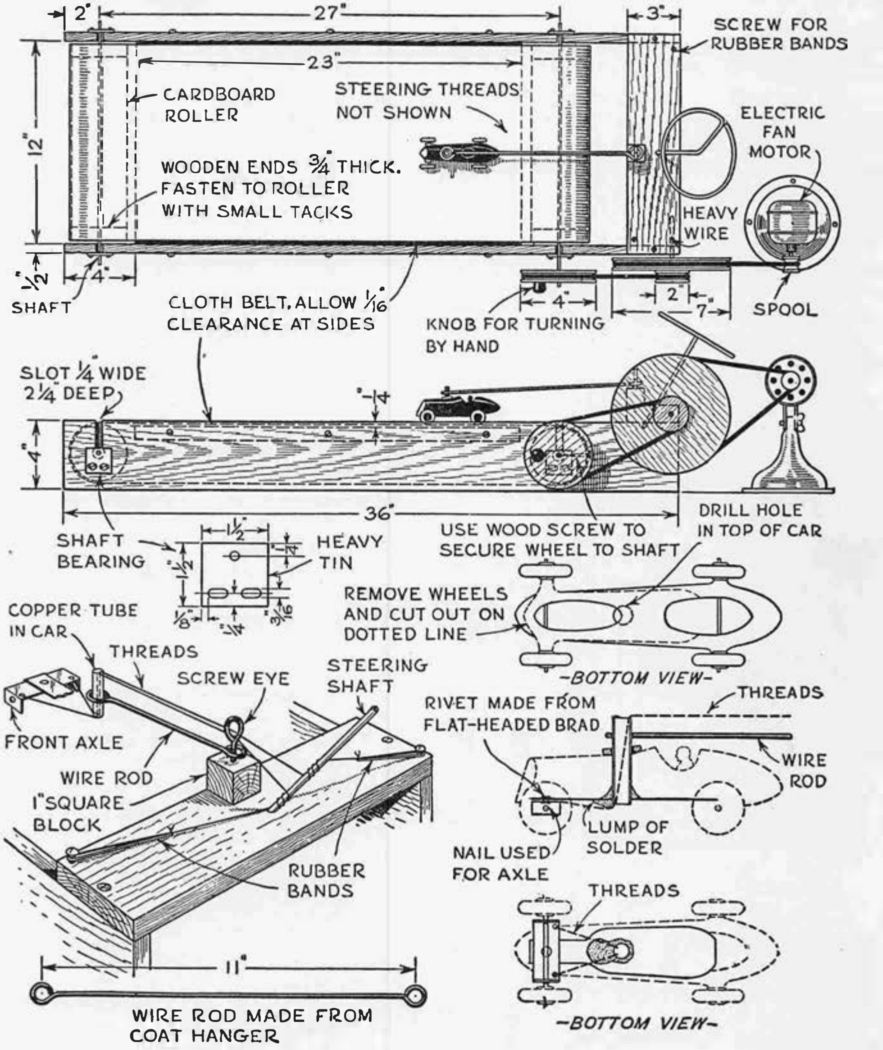
The object of the game is to steer the tiny auto so that it stays on the road and dodges all obstacles. The road is painted on a fast-moving endless belt

HERE'S a new auto-driving game, packed full of thrills and excitement, that can be easily made and set up on the dining room table. A tiny car runs on an endless cloth belt, and you control its movements by means of a small steering wheel at one end of the game board. Marked on the belt is a curving road that appears to be coming toward you at 70, 80, or 90 miles an hour. Your opponent then drops small flat wooden blocks on the road at a fixed distance in front of the miniature car you are steering, and you try desperately to dodge them without running off the road. Whoever dodges the most blocks without a smash-up wins the game.

The device contains no complicated parts, and once constructed, no adjustments are required. The little automobile may be purchased for five or ten cents. The moving belt is ordinary heavy sheeting. Threads lead from the toy car to the steering wheel, but they do not require delicate adjustment because two small rubber bands maintain the proper tension at all times. You may rig up an electric fan motor to drive the belt if convenient, although it is almost as much fun if the belt is turned by hand, and the speed can then be constantly varied.

The general features are shown in the drawings. The only part of the construction that requires special care is in changing the little auto so the front wheels may be steered. The car should have rubber tires and a wheel base of 2½ or 3 in. It should be made of lead-like metal so that parts may be cut away with a knife. Remove the front wheels and the neighboring parts, and remount the wheels as shown so they may turn from side to side. A lump of solder is required on the underside as indicated for reducing friction at the point where the threads enter the upright tube. The tube should be about ⅛ in. inside diameter and 1½ in. long.

Rollers about 3 in. in diameter are easily made from large mailing tubes or the cardboard tube that is found on the inside of a roll of linoleum. Ordinary clothes line wire or No. 10 iron wire is used for shafts for the rollers. Slots in the heavy tin bearings allow the rollers to be adjusted.

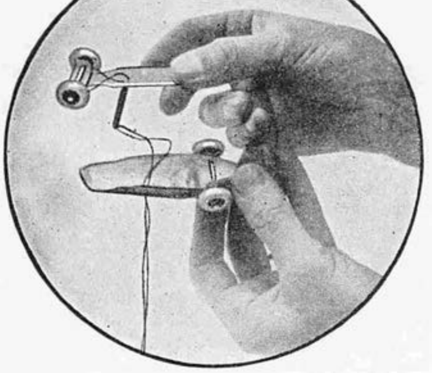


Top and sides views of the assembled game, how the steering threads are arranged, and three views of the toy auto as modified. The endless belt may be turned either by motor or by hand

The cloth belt should be hemmed on both sides. A road with curves and a car to pass are painted on with ink or water colors. Don't make too many curves or have them too sharp.

The steering wheel and mechanism are shown in detail. Solder the joints in the screw eye through which the control threads pass, otherwise the threads may get caught.

The drive wheel on the roller shaft and the spool on the fan-motor shaft are held with wood screws used as set screws. Belts for the driving wheels are made of rope with the ends sewed together. They may be prevented from slipping on the small pulleys by placing one or more rubber bands around the pulleys to lie snugly in



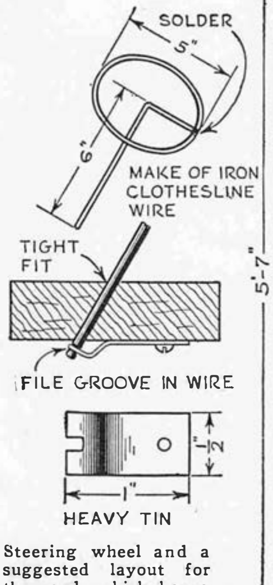
How the front wheels of the toy auto are remounted so that they will steer freely

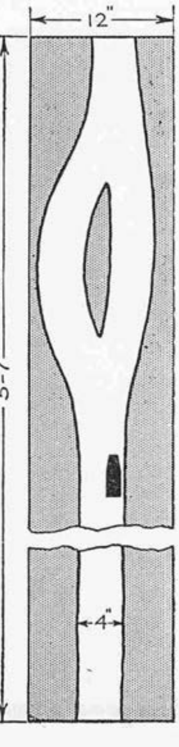
the grooves and to grip the belts firmly.

The steering shaft should be smooth and unpainted where the threads wrap around it; the rubber bands then will keep the threads tight at all times. The bands should be stretched about 1 in.

The cloth belt, of course, moves toward the driver just as the ground seems to be rushing toward you when behind the wheel of a real car. Run the belt at slow speed at first because you will find that the toy auto is a little harder to steer than a real car. It responds more quickly, and the tendency is to turn the wheel too far. The fact that you are not in the car itself seems to make a difference. At first you will have trouble keeping the car headed straight. At low speeds it is fun to try to follow the curves in the road and to pass the other car marked on the road. If you wish to, you can equip several types and sizes of cars for steering, because one may be removed and another substituted in a few minutes.

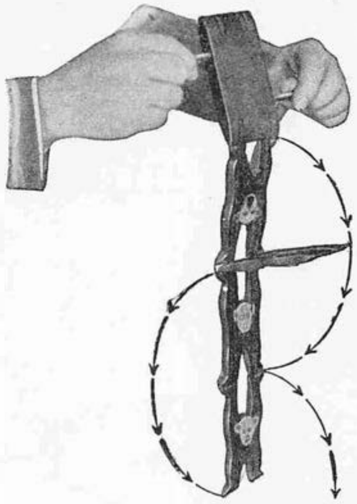
To find the relative speed of the car in miles per hour, multiply the length of the belt in feet by 120 and divide by the wheel base of the car in inches. Then multiply this hypothetical belt length by the R.P.M. and by 60, and divide by 5,280.

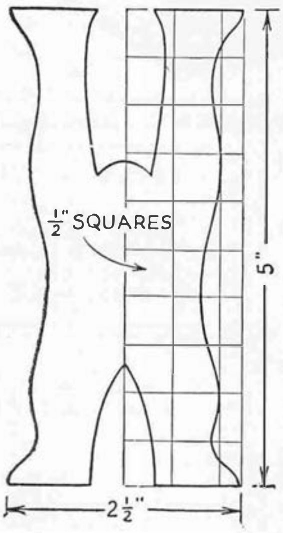


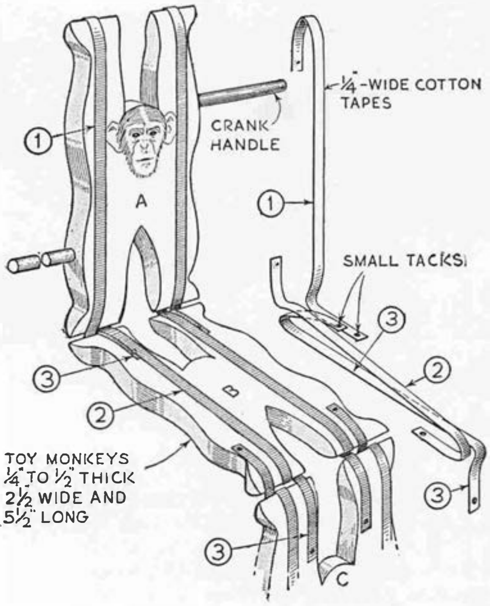


Steering wheel and a suggested layout for the road, which has a parked car painted on

Wooden Monkeys *PERFORM Acrobatics*







Turning the upper block first one way and then the other makes the monkeys do an astonishing series of somersaults. The arrangement of tapes is shown above; the pattern is given at the left

WHEN these acrobatic monkeys go into action, everyone wants to know what makes them work. First they hang by their hands and then, flop! and they all turn somersaults and hang by their feet! It's an old trick dressed up in a new way and quite mysterious even after you understand how they are constructed.

Each monkey—you can make as many as you please—is sawed from a piece of wood from ¼ to ½ in. thick, 2½ in. wide, and 5 in. long. Taper the ends with a block plane or wood rasp, and smooth with file and sandpaper. Stain or paint them brown, and then paint the faces, fingers and toes as suggested in the illustrations. Dowels ¼ in. in diameter and 2¼ in. long are glued into the first monkey as shown on the drawing (or a plain block instead of a monkey may be used as illustrated in the photograph).

The monkeys are fastened together with ¼-in. cotton tape and small carpet tacks. Tapes No. 1 are nailed to the back of monkey *A*, then stretched over its front and nailed to the back of *B*. Tapes No. 2 also start on the back of *A*, pass over the front of *B*, and end on its back. Tapes No. 3 start under tapes No. 2 on the front of *B*, pass over its back, and end on the front of *C*, and so on. Each monkey, with the exception of the first and last, has a pair of tapes stretched both over its front and its back.

To make them do stunts, turn the handles half a turn in one direction and then half a turn in the other direction. The faster you work, the faster they work.

This toy is well suited to window display purposes if it is made long enough so that it can be worked mechanically from above without being seen from the street. Any number of monkeys may be used. You can change the design to clowns or bears if you like, or paint monkeys on one side and bears on the other, which makes the acrobatics even more mystifying.

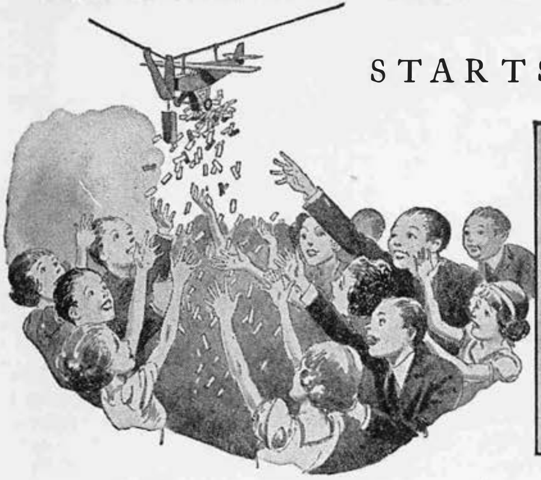
OLD BALL BEARINGS ACT AS COASTER WHEELS

Boys' coasters are usually made with wheels from roller skates. An even cheaper source of wheels is old ball bearings from discarded automobiles; these will make coasters having an extremely low center of gravity.

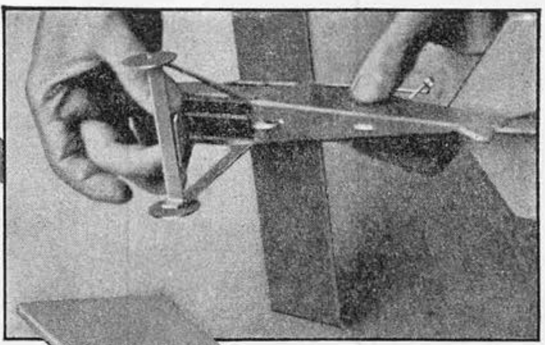
The outer race of the bearing acts as the rim of the wheel, while the inner race serves as a "hub." The inner race can be bolted to an axle, or, better still, driven over a wooden cross member whose end has been rounded off to fit. The rounded portion should project ½ in. or more beyond the outside of the bearing so that a hole may be drilled for the insertion of a long nail, to keep the wheel in place. The bearings used on various automobiles vary considerably; the best kind to get is the single-row deep-groove type. A suitable set can often be found in the rear-end housing of a light car.

Ticket-Dropping Airplane

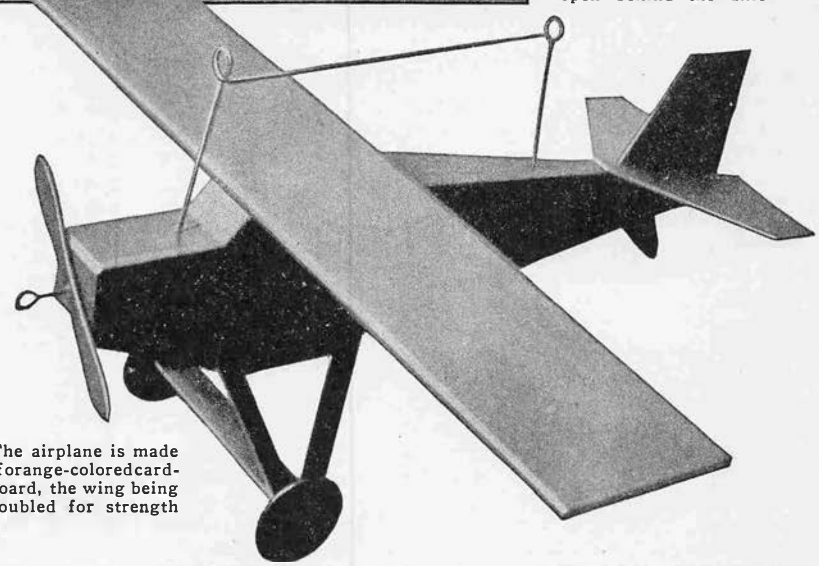
STARTS PARTY OFF WITH A BANG



The cardboard plane slides down a wire, hits the backstop, and dumps a load of tiny prize tickets



The underside of the plane showing the ticket compartment. The hinged door can be seen open behind the axle

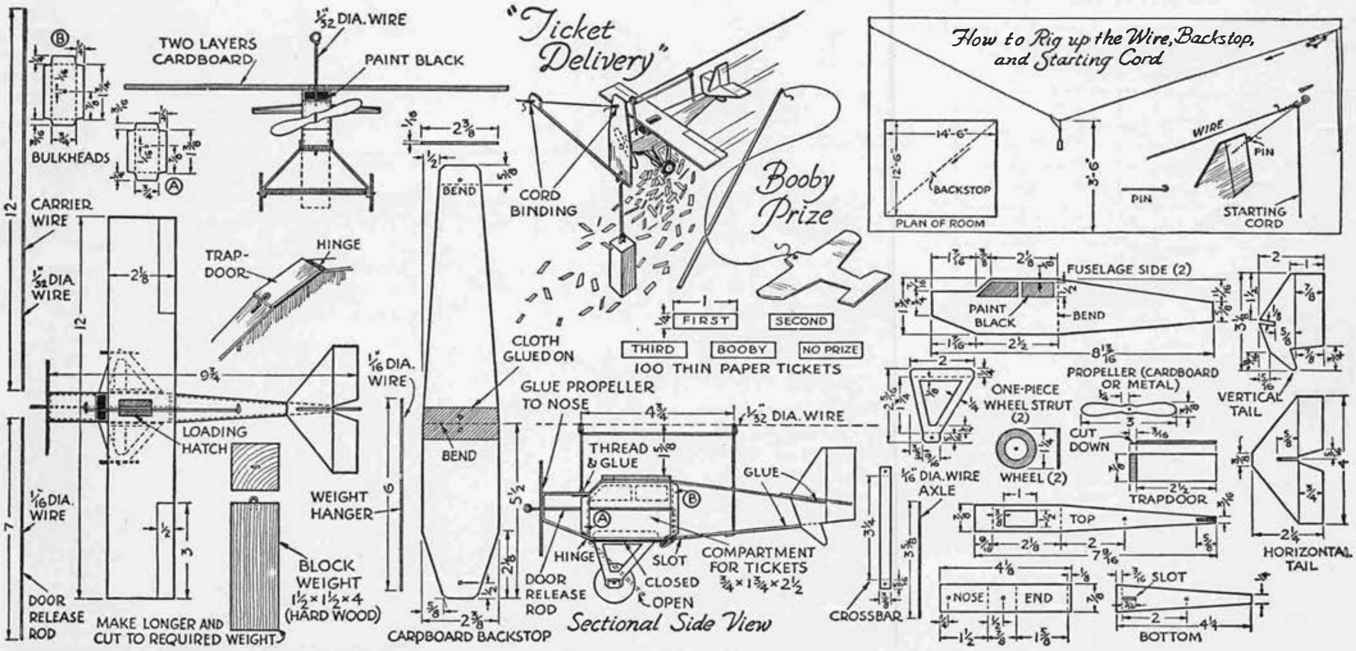


The airplane is made of orange-colored cardboard, the wing being doubled for strength

HERE is a novelty that will make a big hit at any gathering of young folks. All present except the host or hostess stand in a large circle. Any appropriate little airplane verse is recited, or a few introductory remarks are made about a ticket-dropping plane that is about to bring a load of good luck. Then the host or hostess jerks the starting cord, and a miniature plane slides rapidly down a wire and dumps a load of tickets in the midst of the guests, who scramble to pick them up. The resulting confusion and laughter will break the ice and start the party off in the right spirit of hilarity.

If twenty persons, for example, are present, 100 tickets are used, and each person is allowed to pick up five. Holders of the prize tickets are then lined up to receive their awards in order, and the big laugh comes when the person with the "booby" ticket is given a tiny airplane on a stick. Some slips are marked "no prize" to confuse the finders.

The airplane itself is made almost entirely of show-card board. All parts are glued together, and the wing is made of two layers. Construct the plane and rig up the wire, backstop, and starting cord as shown in the drawings. The plane should be loaded beforehand. and the backstop can be tied back out of the way with a string until it is actually needed.



Top and front views of the assembled plane, a sectional view to show the ticket compartment, details of all parts, and diagrams of the set-up

BOY'S WORKBENCH AND TOOL CABINET CONCEALED IN NEAT-LOOKING DESK

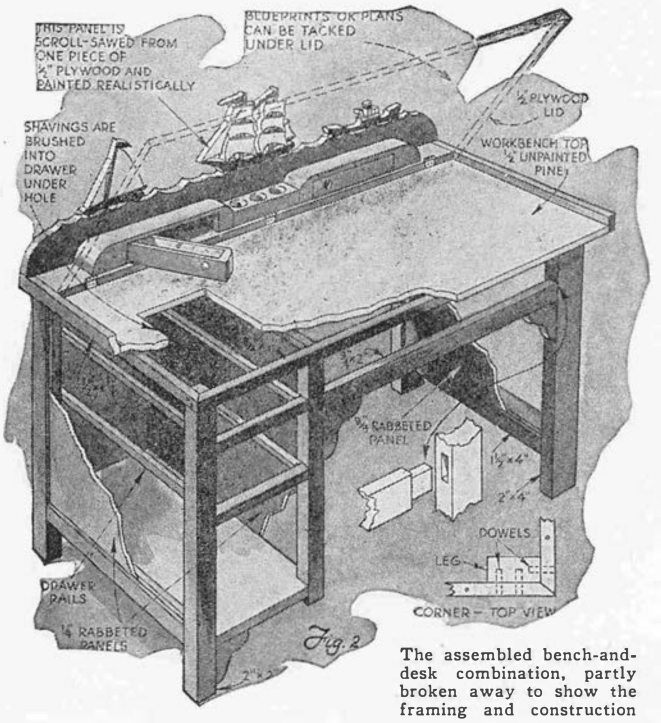

THIS PANEL IS SCROLL-SAWED FROM ONE PIECE OF ½" PLYWOOD AND PAINTED REALISTICALLY
BLUEPRINTS OR PLANS CAN BE TACKED UNDER LID
½" PLYWOOD LID
SHAVINGS ARE BRUSHED INTO DRAWER UNDER HOLE
WORKBENCH TOP ½" UNPAINTED PINE
¾" RABBETED PANEL
1½"×4"
2"×4"
DOWELS
LEG
CORNER — TOP VIEW
DRAWER RAILS
¼" RABBETED PANELS
2"×2"

Fig. 2

The assembled bench-and-desk combination, partly broken away to show the framing and construction

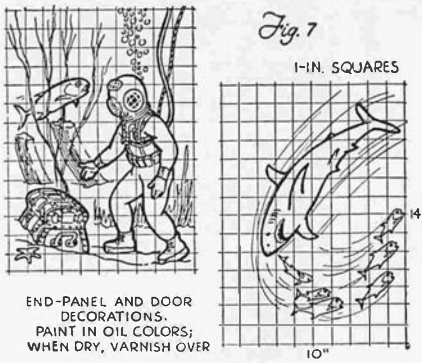


Fig. 7

END-PANEL AND DOOR DECORATIONS. PAINT IN OIL COLORS; WHEN DRY, VARNISH OVER

THIS combination desk and workbench is intended to be finished in a driftwood effect to harmonize with the double-deck bed and the dresser described on the following pages, but, of course, it will stand very well by itself in any room a boy uses both for study and craftwork.

As a desk, it presents a clean, smooth top, with pivoted pencil boxes. There is a shelf for books and magazines, and drawer space for paper and other material.

When the top is lifted, it becomes a workbench for making ship models, airplanes, and other projects—a smooth, unpainted pine bench with a well at one end into which shavings are brushed after the day's work, permitting the top to be turned down flat.

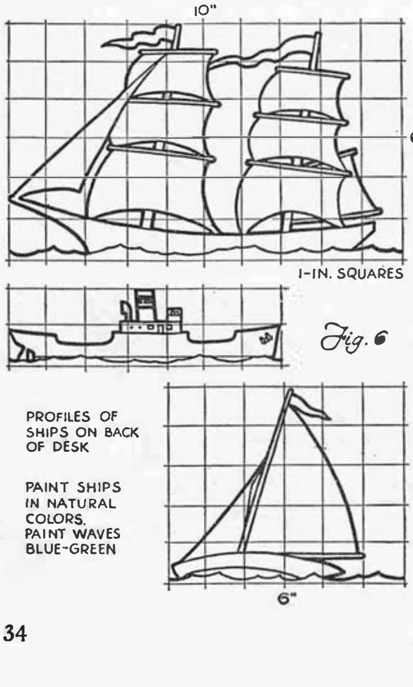


Fig. 6

PROFILES OF SHIPS ON BACK OF DESK

PAINT SHIPS IN NATURAL COLORS. PAINT WAVES BLUE-GREEN

At the right end a panel opens to disclose a tool rack as well as horizontal compartments for long balsa sticks, which so often become broken when not properly stored away. As the compartments are long—the full length of the bench—a novel arrangement is provided for pulling out short pieces which slip back in the pigeonhole. This consists of a block that fits loosely in the compartment and to which a long wire is attached.

General dimensions are given in Fig. 1, and constructional details in the cutaway perspective, Fig. 2. Note that two of the legs on the left are 2 by 2 in. (net), and the pair on the right are full 2 by 4 in. in order to make room for the tool panel illustrated in Fig. 3. The four legs are tied together at the top with rails to which the workbench top is screwed, as indicated in Fig. 2. Mortises and tenons re-enforced with glue are used for the principal joints.

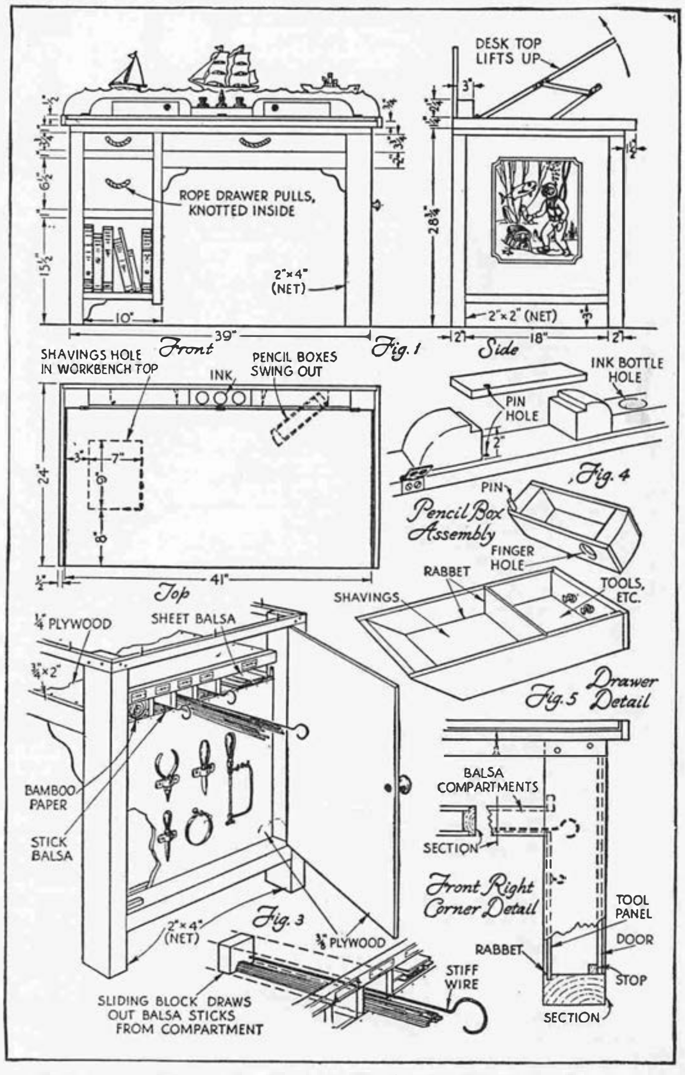
The plywood panels are set into rabbets. The hinged desk lid is a single piece of ½-in. plywood, held up by a folding stay or bracket on the left end.

The pencil boxes are shown in Fig. 4. These swing on a pin at one end, and the toppiece is installed after the box and pin are in place. Receptacles for ink bottles are provided in the center.

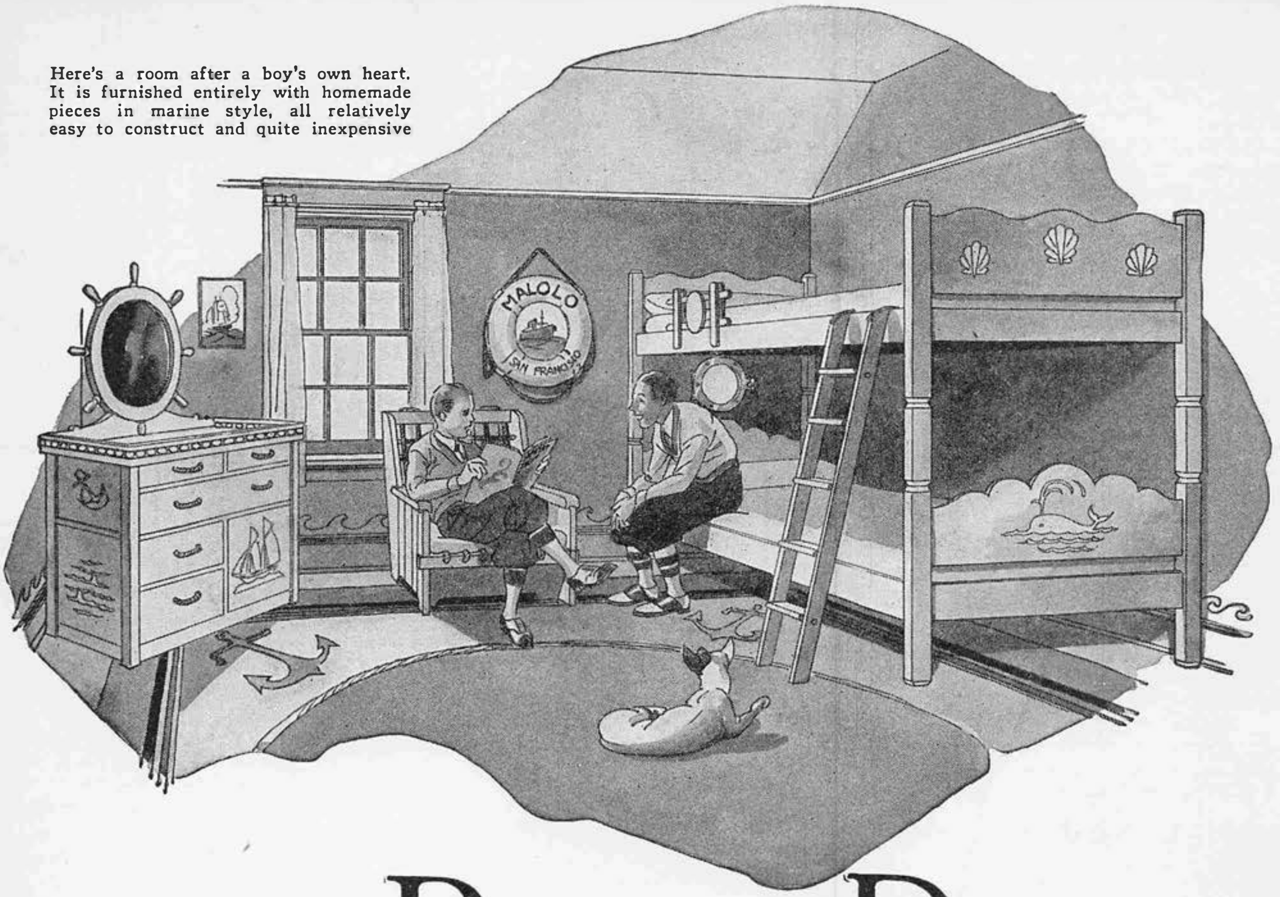
In Fig. 5 is shown the drawer which slides under the shaving well. Note that the end is inclined so that removal of the last scrap of shavings is made easy without turning the drawer upside down.

The ornamental ships are scroll-sawed from ½-in. plywood. They can be cut separately from the panel which supports them and then glued in place. The profiles are given in Fig. 6. After they have been cut, touch them up in realistic effect. Use a bluish white for the sails, and add colored pennants and brown rigging. The hull of the square-rigger may be black with a white molding.

Suggestions for painting decorations on the end panels are given in Fig. 7, but if your artistic ability is not equal to these, cut out colored magazine illustrations and glue them on, then protect the paper with a coat of clear varnish.



General assembly drawings and details of tool cabinet and other parts



Here's a room after a boy's own heart. It is furnished entirely with homemade pieces in marine style, all relatively easy to construct and quite inexpensive

A PICTURESQUE BUT PRACTICAL BOY'S ROOM

Furnished Like a Ship's Fo'c'stle

FURNITURE of marine design is not only unusually practical for a boy's room, but much simpler to construct than the appearance of the finished pieces would lead one to imagine. Finished in a driftwood effect and with deep-sea decorations in bright colors, this bedroom set will please any young man, especially if he is allowed to help his father build it.

The double-decker bed, Fig. 6, is arranged so that the top bunk can be lifted off and used elsewhere. There is ample room between the berths for dressing, and a portable ladder gives easy access to the upper berth. A sliding guard is also provided to prevent small or restless sleepers from "falling overboard." The guard simply straddles the side rail, and can be lifted off when not needed.

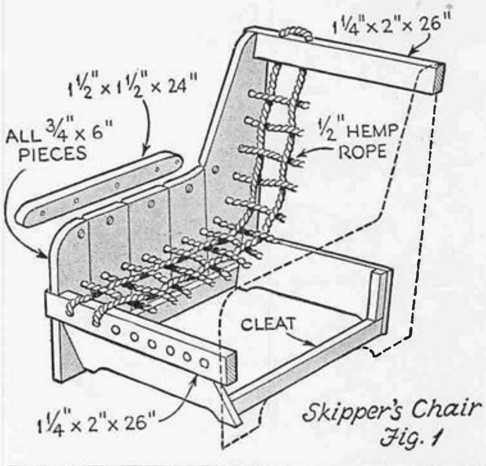
Construction details are given in Fig. 7. The corner posts are all square—3¼ by 3¼-in. pine, redwood, or what you select. The ends form assembled units, consisting of head- or footboard and end rail mortised into the posts and secured with casein glue. These ends can then be attached to the side rails by means of bed hooks, which slip into slots in the bedposts. The bed hooks are standard and can be purchased at any large hardware store. Neatly fitted joints are desirable where the side rail abuts upon the post. A hardwood slat rail is screwed to the side rail as shown.

All dimensions given are net. Bear in mind that if you ask at the lumber mill for a 2 by 5-in. or a ¾ by 12-in. board, surfaced (finished), you will get something considerably smaller, so be sure to specify net dimensions when ordering material, if it is surfaced.

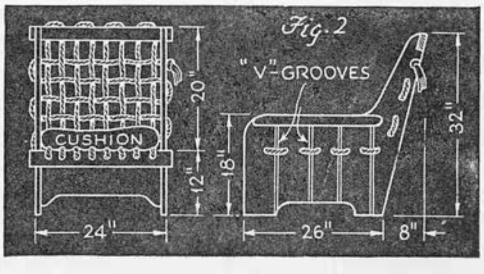
A comfortable "skipper's chair" is shown in Figs. 1 and 2. The sides are upright boards cleated together as shown, and with V-grooves at the joints on the outside. Bore ⅝-in. holes for the rope, and weave the ropes as indicated. The ends are knotted and about 8 in. of the strands unraveled.

Port lights (Fig. 8) set into the wall at the heads of the beds are excellent for reading. These will require breaking away some of the plaster and blocking in between studs, then patching the edges to conform to the port-light frame. Frames of this kind may be obtained from a marine hardware supply house in convenient sizes.

Ring buoys with the name of some favorite ship form an interesting feature of the room. They can be made of white duck as illus-



Skipper's Chair
Fig. 1

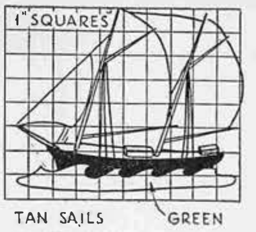


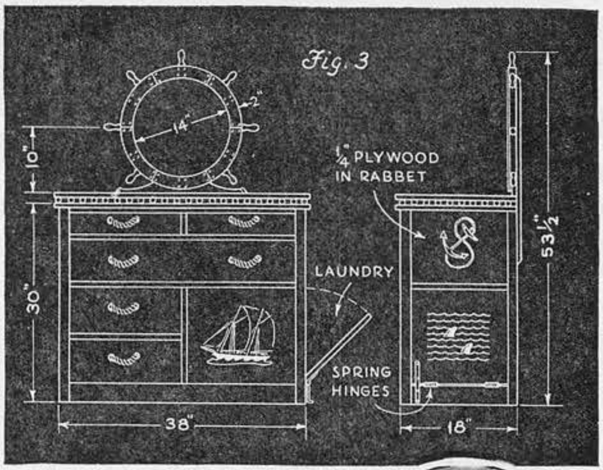
The armchair is wide and low, and the network of rope, when covered with cushions, makes an inviting and comfortable seat for long winter evenings trated in Fig. 9, painted white, with the name in black and the line's flag in color. Clothes hooks in the form of anchors can be sawed from plywood and painted a slate gray.

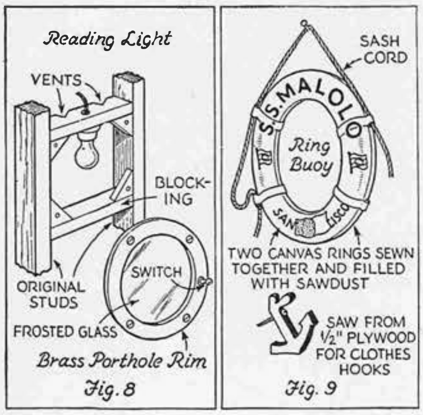
The pilot-wheel dresser (Figs. 3 and 4) makes an immediate hit. In Fig. 5 are given assembly details of the pilot wheel. It is built up of twelve curved pieces, doweled and glued together, with seven turned handles set in the rim. After the frame is glued up, screw it to the bench so that the special "sanding compass," made as shown, can be used for truing up the rim. Use coarse sandpaper at first, then finer grades, shimming with pasteboard under the sandpaper. The inside also can be trued in the same manner. If a shaper is available, give the rim a molding.

Spring hinges keep closed the tilting panel to the laundry compartment of the dresser. It is opened by a piece of strap iron bent to form a pedal. Holes should be bored in the back panel of this compartment for ventilation.

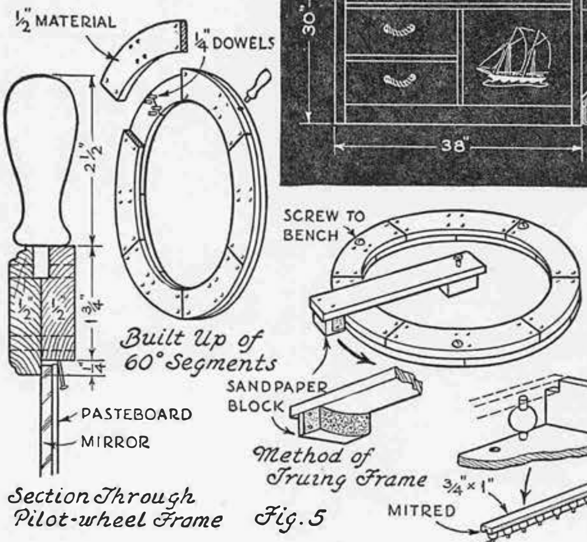
Appropriate designs for the panels should be painted in bright colors. The wood should first be finished in a driftwood stain and antiqued with an application of rottenstone, or painted to harmonize with the wall and woodwork finish.

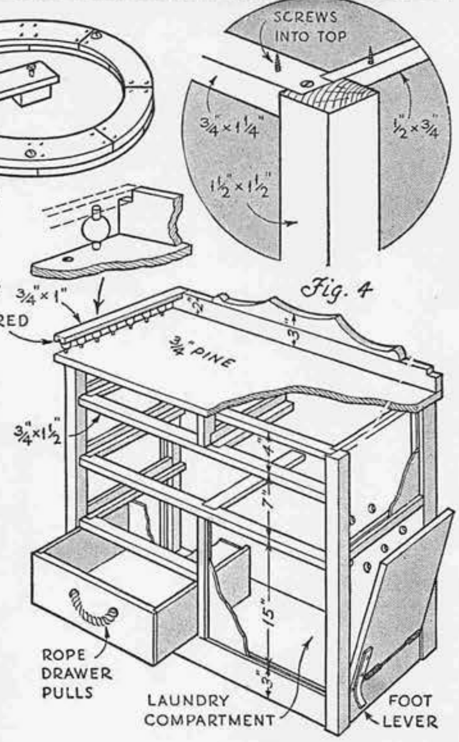


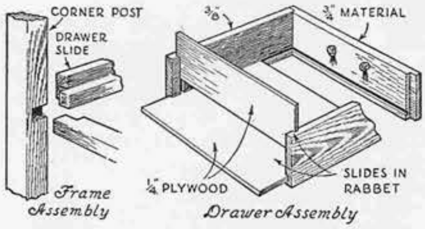




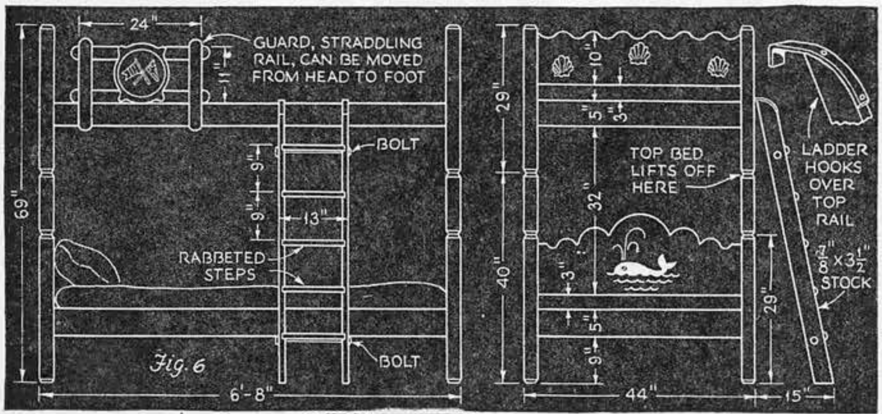
Three novel suggestions—a porthole type reading light, ring buoy, and clothes hook

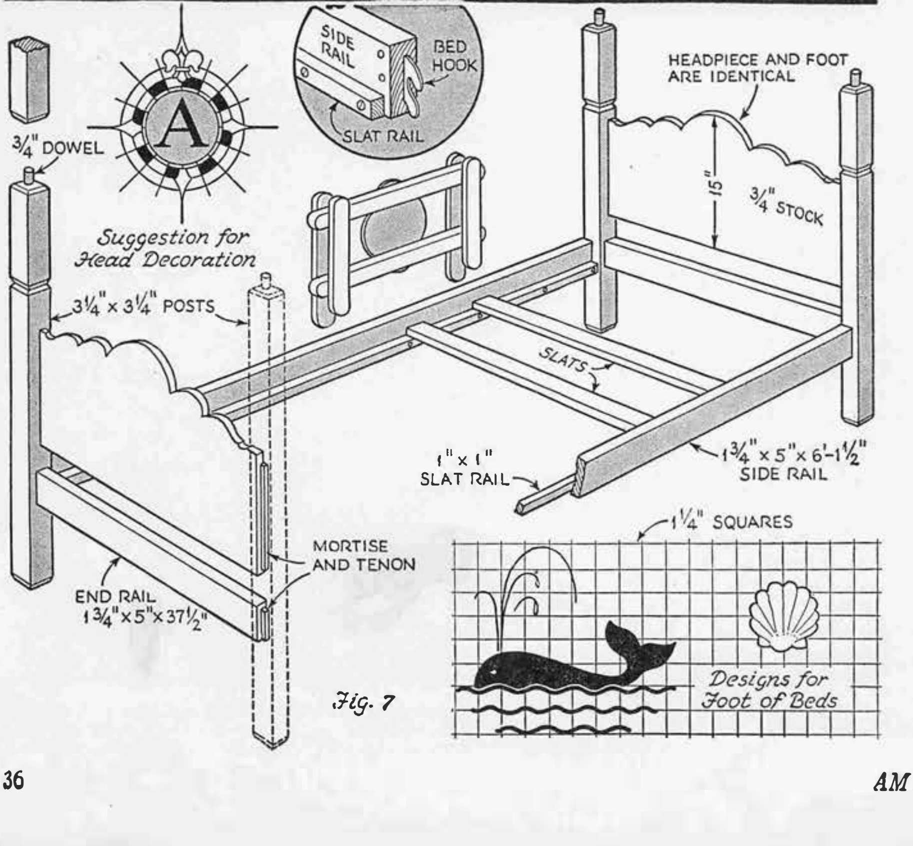






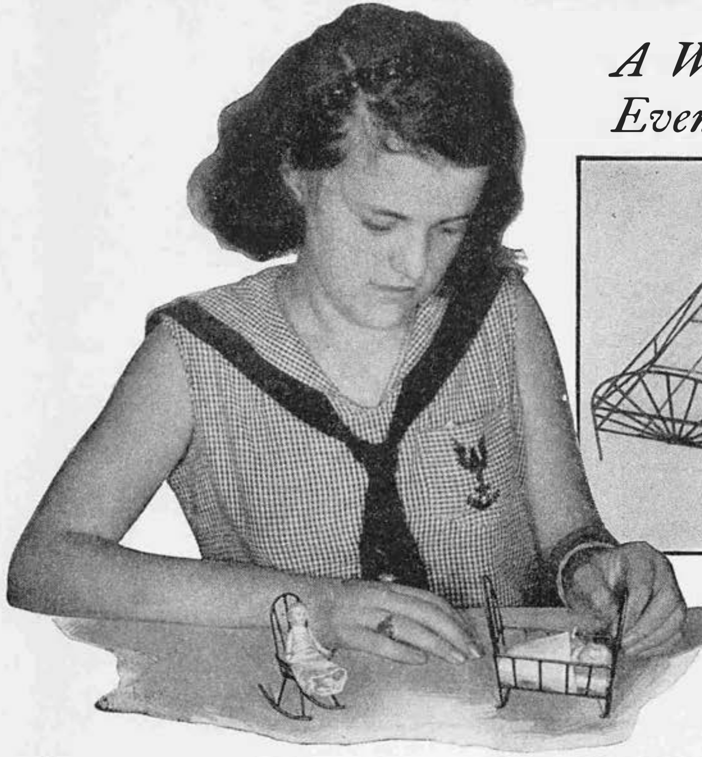
How the framework of the dresser is put together, and method of constructing drawers

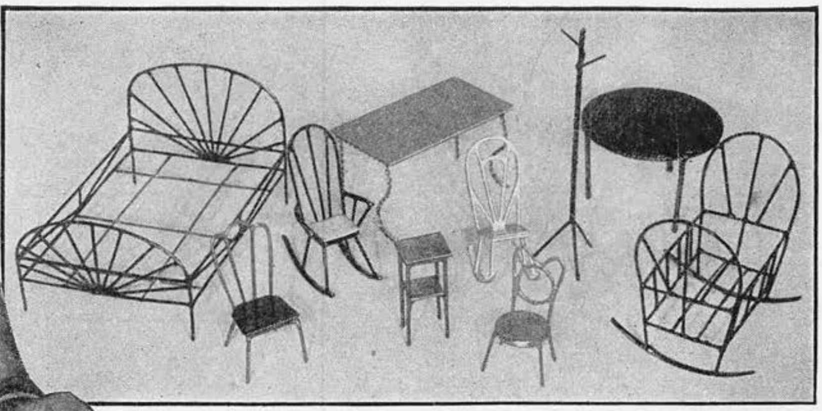




Everlasting Doll Furniture

A Whole Set Made in a Single Evening from Discarded Wire





Toy furniture made mainly from copper wire. Most of it is finished with melted sealing wax. The round table, which has twisted wire legs, upheld a weight of 51 lb. before one of the legs began to give way

DOLL furniture is usually limited as to size, finish, and variety of design, and is often of fragile construction. The type illustrated, however, is very sturdy and easily repaired, and an entire set can be constructed and finished in a single evening. In fact, all these pieces were made from the wire from a discarded electric light line and an old radio aerial. The expense was limited to ten cents for rosin-core solder and twenty cents for sealing wax, only half of which was used.

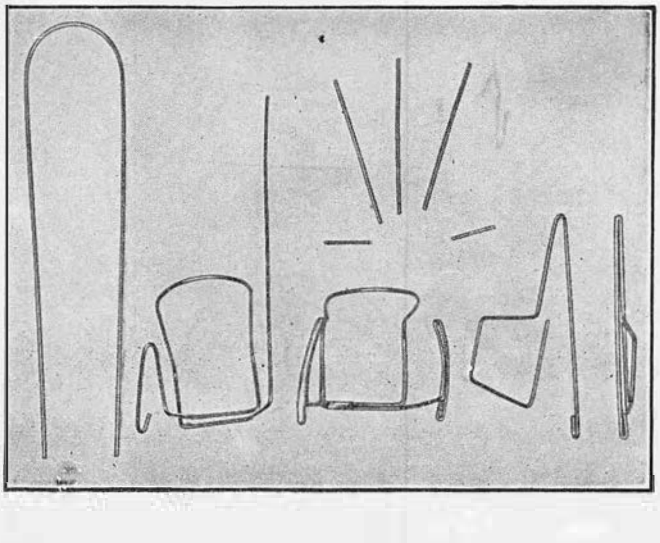
A length of hard-drawn copper aerial wire can be purchased for twenty or twenty-five cents if you have no discarded wire of at least No. 12 gauge handy. If you use old wire, put it in the furnace to burn the insulation off and then brighten it up with a piece of emery cloth or sandpaper. Cut it into short lengths for easier handling and straighten it by drawing it between three nails driven into a board and spaced about 1½ in. apart.

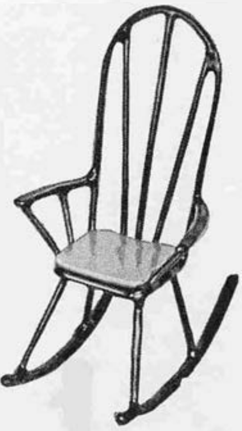
To construct the bed, first bend two identical rectangles for the main bed frame, space them about ¾ in. apart, and connect them with long V-shaped stiffeners as illustrated. Next bend the two pieces that will form the head- and footboards, and solder them securely to the box section. Heat the joint first with the soldering iron and then apply the solder, giving it plenty of time to penetrate the joint and burn out the flux. You may want to wear an old glove on the hand that is holding the wires because copper transmits heat rather rapidly. The head- and footboard decorations are next fastened in. Start with the central bar, soldering it first at the bottom, and leave the upper end of the wire long enough for handling without getting too hot. Then cut the wire carefully to length and solder. The other bars follow. Solder one on each side of the central bar and move to the next pair. Trim the legs to equal length, and the bed is finished.

The rocking armchair, if properly proportioned, will be attractive enough to serve as an ornament as well as a toy. Start with a straight piece of wire bent in the center to form the top of the chair back. Be careful of the radius because it must be absolutely true. A spool or broom handle may be used as a jig. Determine the height of the back and then bend the back up to form the seat. Holding the wire with a scale or a piece of wood will help to keep the back straight. The two ends are then bent to form the seat. The wires should cross each other at the front edge of the seat; they are then bent upward until they are almost vertical to form the supports for the arms of the chair. Now bend each wire back, parallel with the side of the seat, to a point about ¼ in. beyond the upright part of the back. Bend the wire back sharply upon itself and pinch the bend tight with the pliers. The wire is carried forward to ⅜ in. beyond the upright arm support and again bent back sharply and trimmed where it meets the upright. Carefully radius the arms until the rear ends just meet the back, and solder them in place.

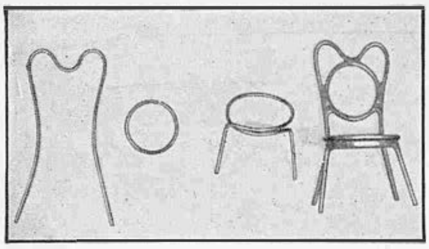
The rockers are made in the same way as the arms except that there is, of course, a separate piece of wire for each rocker and support. Solder the rocker supports to the seat of the chair, keeping the rocker supports inside the square that forms the seat. Fill the space between the doubled wires of the arms and rockers with solder.

Now assemble the three bars in the back and also the small support under the center of each arm. This support takes the strain off the soldered joint at the rear end of the arms.





An unusually decorative rocking chair. At the left is shown the method of bending the wire parts



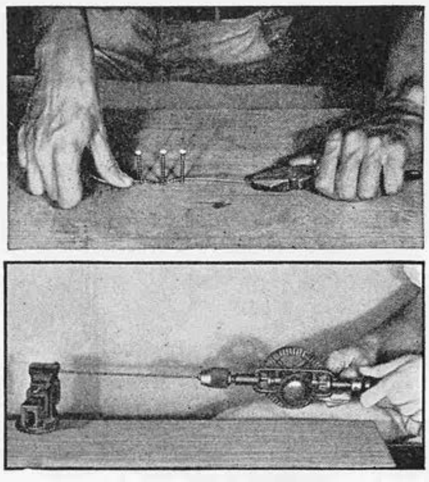
The round-bottom chair is made from three wire pieces and a cardboard disk for the seat

The chair with the round seat is quickly made by bending a piece of wire around a round object for one and a quarter turns and bending the ends downward to form the front legs. The back of the chair and the back legs are bent from one piece and soldered in place. Then the decorative ring is added. The seats for all of the chairs as well as the table tops are made from cardboard.

For the larger pieces such as tables, a more rigid construction may be necessary. Heavier wire may be used, but a more ornamental method is to grip one end of two or three wires in the vise and twist them into a single bar with a hand drill or a carpenter's brace. The three-legged table thus constructed withstood a load of 51 lb. before one leg buckled.

While any of this furniture can be finished by painting, it was found that paint not only emphasized the slight irregularity of the wires, but also required several carefully applied coats to finish each piece. On the contrary, sealing wax covered perfectly with a single coat and produced a lustrous finish that was unobtainable with paint. The sealing wax, which is the kind sold for craftwork, can be obtained in a large assortment of colors, including gold and silver. Simply heat the wax over a small alcohol flame and dab a little upon the wire to be covered. Then hold the wire over the flame and let the wax flow evenly over the surface. It sets almost immediately.

The chair seats and table tops are finished by covering them with sealing wax, both top and bottom. They are then heated a little and stuck on the furniture. Another method is to cover them with bright-colored cloth.



Twisting wire for use in the heavier pieces and, above, a good way to straighten old wire

Those articles made from twisted wire look well if the wire is thoroughly polished before it is twisted and then left without further covering except perhaps a coat of very thin transparent lacquer to prevent tarnishing. Black sealing wax makes a beautiful finish for the smaller furniture.

Circus Dog Toy

for Small Children

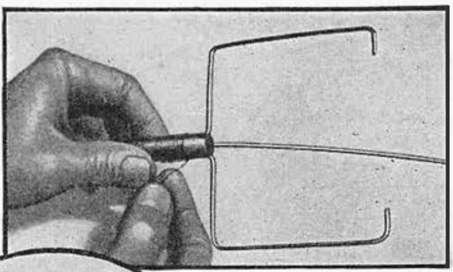
As the toy is pushed along the floor, the dog jumps up and down with a rolling motion

THIS circus dog rolling a cylinder is a simple, sturdy, and amusing toy for a small child.

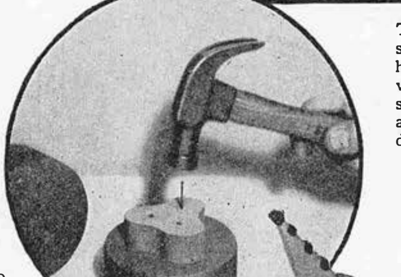
The dog is drawn full size on a piece of ½-in. plywood and cut out. The cam, which is 3 in. in diameter and shaped as shown in one of the photographs, is also made from ½-in. plywood. The two wheels, which are 4 in. in diameter, are cut or turned from 1½-in. solid wood. The cam is glued and nailed to one of the wheels; then the other wheel is nailed on. These parts are painted in brilliant colors.

The handle is a piece of ½-in. dowel 22 in. long. It is grooved in three places at one end, and the other end is rounded. The three bent-wire pieces are set in the groves and wrapped with No. 20 copper wire. Solder this assembly securely. Put two small screw eyes in the dog as shown and slide the supporting wire through these eyes before finishing the bending to form the dog's tail. Drill a ⅛-in. hole in the center of each roller, put a washer over the holes, and snap in the wires.

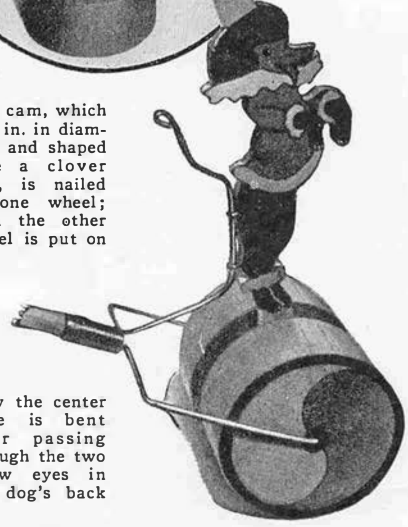
As the toy is pushed along, the dog jumps up and down.



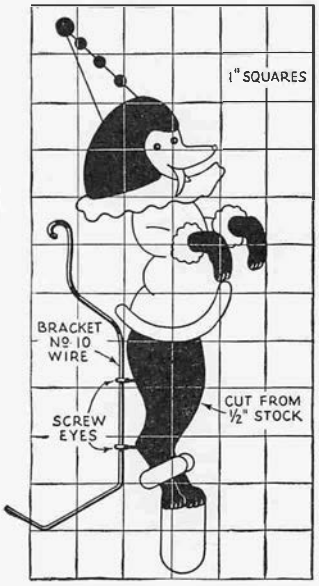
The three wires are set in grooves in the handle and bound with wire. The size and shape of these wires are made clear in the drawings at the right

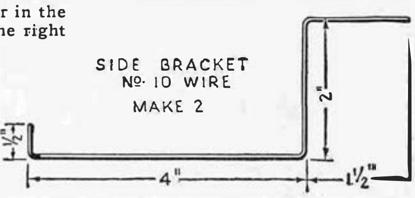


The cam, which is 3 in. in diameter and shaped like a clover leaf, is nailed to one wheel; then the other wheel is put on



How the center wire is bent after passing through the two screw eyes in the dog's back





CHILD'S MERRY-GO-ROUND BUILT ON AUTO AXLE

SMALL children can enjoy themselves safely on this tiny carrousel. It revolves on a model-T Ford front axle assembly. The platform is fastened to two crosspieces which are, in turn, bolted to the wheel hub. The axle is cut in half and buried in concrete.

TEN EASILY MADE
Games... Toys... Novelties

YOUR home workshop can help Santa Claus out a lot when it comes to making games, toys, and small novelties. The accompanying drawings offer ten suggestions, and you can use almost any of them as a starting point for additional designs of your own.

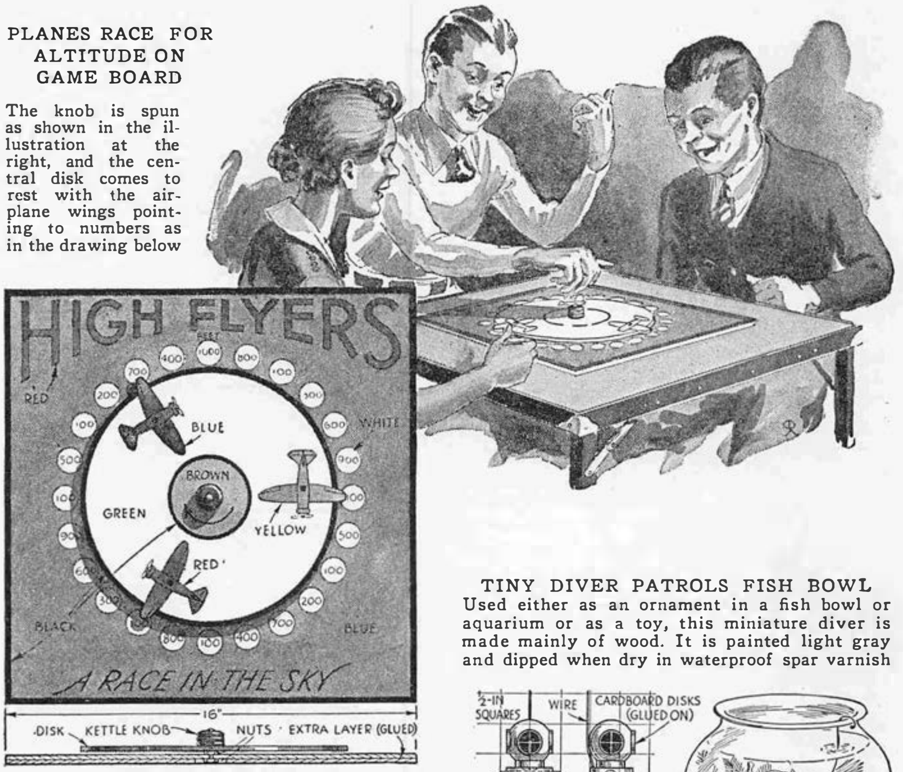
In the high flyers game, each player spins the disk once in turn and scores the number to which the wing tip of his plane points. If the tip points to the blue sky between the numbered circles, one additional spin is allowed. Score is kept, and the player whose plane reaches 5,000 or 10,000 ft. first is the winner. The game can be speeded up, if desired, by counting the numbers to which all three planes point after each spin.

Any number may play the rollio game. The player puts the block on the tail of the arrow with the beveled side up and gives it a slight push with one finger. If the block stops on a line, an extra play is allowed, but if it again stops on a line, no score is made.

The toy airplane is lifted bodily by the wire loop and held until the base spins all the way down. It is then set on the table, and the plane will start by itself and revolve a number of times—fourteen

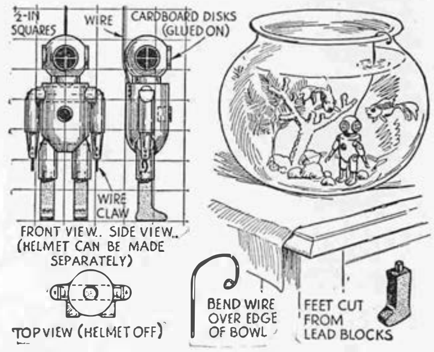
PLANES RACE FOR ALTITUDE ON GAME BOARD

The knob is spun as shown in the illustration at the right, and the central disk comes to rest with the airplane wings pointing to numbers as in the drawing below



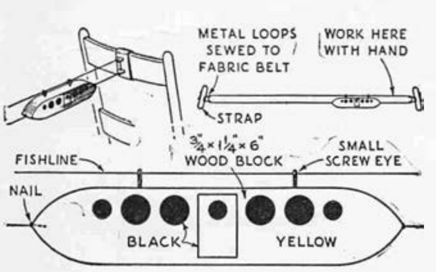
TINY DIVER PATROLS FISH BOWL

Used either as an ornament in a fish bowl or aquarium or as a toy, this miniature diver is made mainly of wood. It is painted light gray and dipped when dry in waterproof spar varnish


½-IN SQUARES
WIRE
CARDBOARD DISKS (GLUED ON)
WIRE CLAW
FRONT VIEW. SIDE VIEW. (HELMET CAN BE MADE SEPARATELY)
TOP VIEW (HELMET OFF)
BEND WIRE OVER EDGE OF BOWL
FEET CUT FROM LEAD BLOCKS

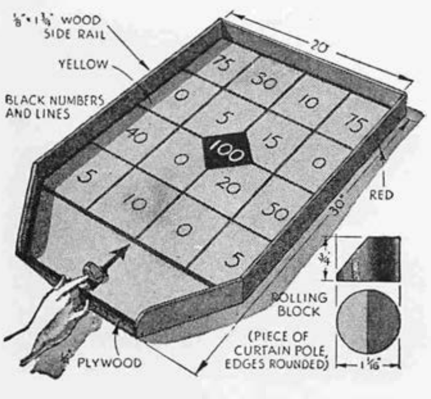
AEROCAR TRAVELS BETWEEN CHAIRS

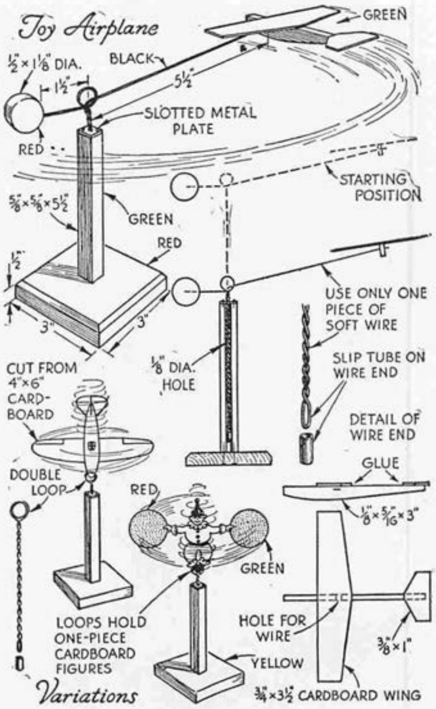
This miniature aerocar is whittled from wood and suspended from a line running between two kitchen chairs or any other convenient supports



ROLLIO GAME KEEPS ONE GUESSING

What makes the game shown below interesting to players and spectators alike is the way the odd-shaped rolling block flops down the board



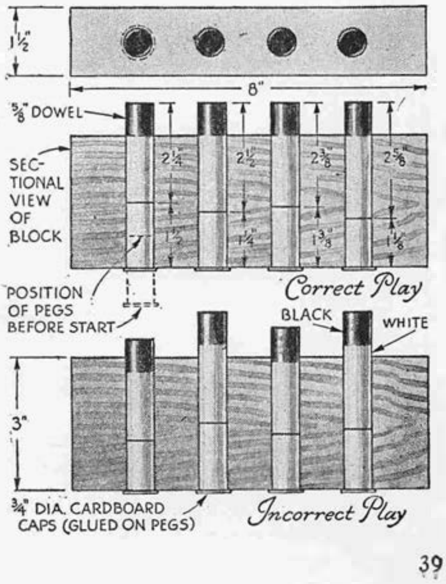


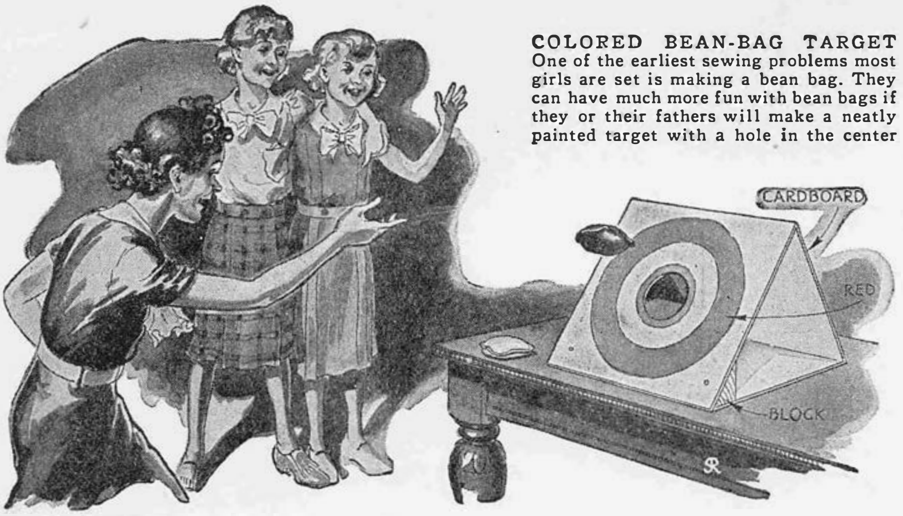
WHIRLING TOYS MOUNTED ON WIRE

Small cardboard airplanes and a large variety of other toy figures, such as a whirling clown, may be mounted on twisted wire so that they revolve in a realistic manner. The action is similar to that of the familiar spiral screw driver

CURIOUS PUZZLE MADE WITH PEGS

The push-peg puzzle shown below requires eight pegs of various lengths. The four pegs having black ends are first pushed in as far as they will go, then the others are inserted opposite



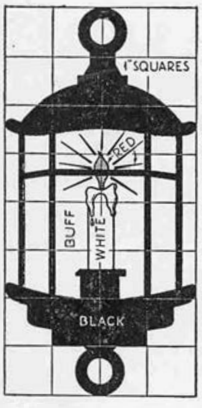


COLORED BEAN-BAG TARGET
One of the earliest sewing problems most girls are set is making a bean bag. They can have much more fun with bean bags if they or their fathers will make a neatly painted target with a hole in the center

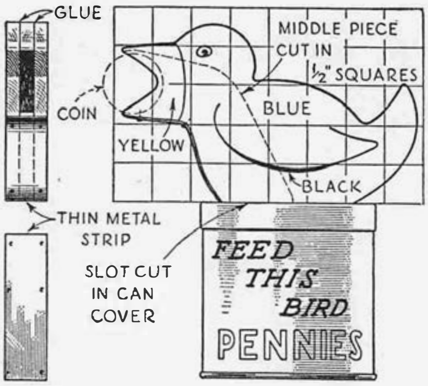
in the case of the original model. Note that the wire is a single continuous length.

In the push-peg puzzle, the long pegs, which are painted black for ¾ in. at one end, are mixed up and pushed all the way into the holes from one side until the dark ends are flush with the block. The short pegs are then mixed up and pushed, one at a time, into the holes on the opposite side of the block as far as the cardboard caps will allow them to go. They will, of course, partly push out the longer blocks. If they happen to do so in such a way that only the black portion of each block projects, the puzzle is solved.

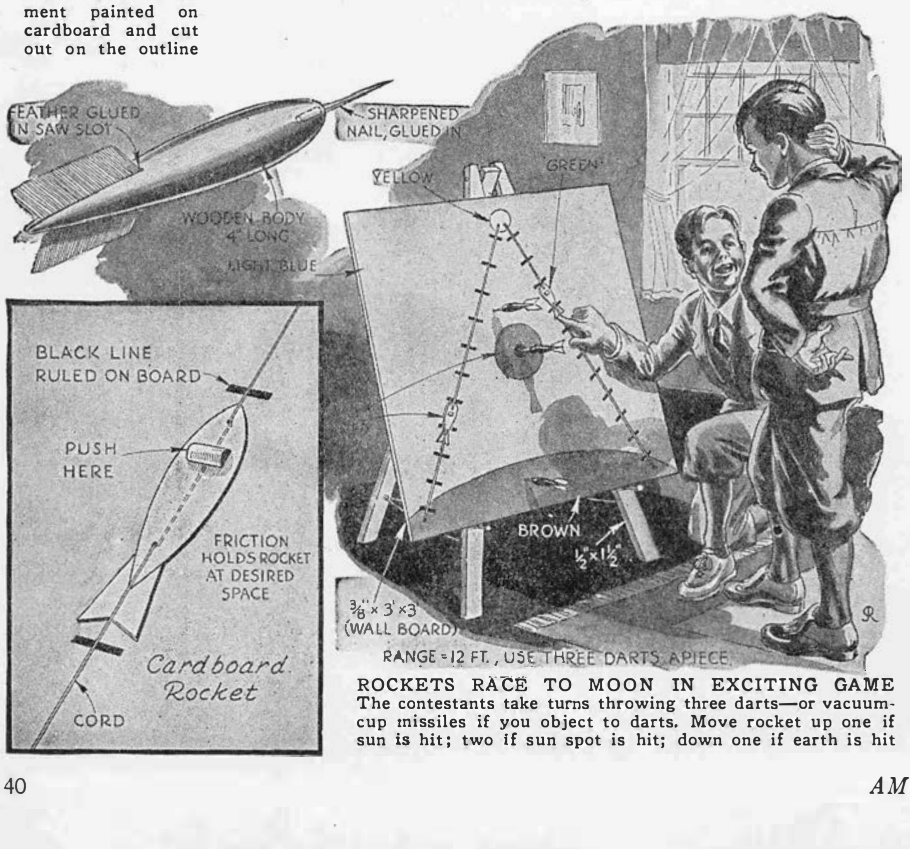
The rocket race is played by two players or two groups.



WALL LANTERN
A Christmas ornament painted on cardboard and cut out on the outline



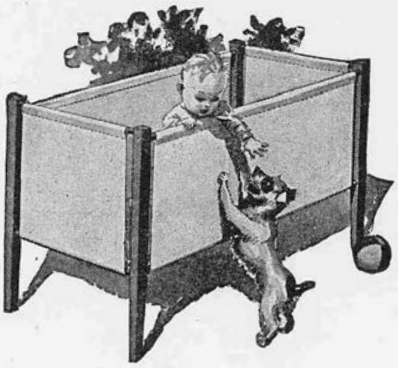
PENNY BANK SHAPED LIKE A BIRD
The bird is made from three pieces of wood, all jig-sawed at once. The central piece is about ⅛ in. thick, but the outer ones may be a trifle thicker. Cut the middle piece as shown by the dotted line, assemble the three, and close the front of the slot with a strip of thin metal. Fasten the finished bird over a slot cut in the top of a tin can

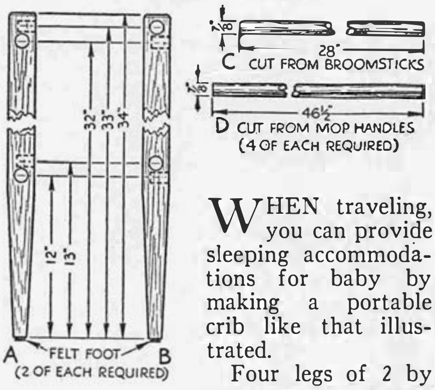


FEATHER GLUED IN SAW SLOT
SHARPENED NAIL, GLUED IN
WOODEN BODY 4" LONG
LIGHT BLUE
YELLOW
GREEN
BLACK LINE RULED ON BOARD
PUSH HERE
FRICTION HOLDS ROCKET AT DESIRED SPACE
Cardboard Rocket
CORD
BROWN
½"×1½"
⅜"×3'×3' (WALL BOARD)
RANGE = 12 FT., USE THREE DARTS APIECE

ROCKETS RACE TO MOON IN EXCITING GAME
The contestants take turns throwing three darts—or vacuum-cup missiles if you object to darts. Move rocket up one if sun is hit; two if sun spot is hit; down one if earth is hit

FOLDING CRIB FOR USE ON TRIPS FROM HOME

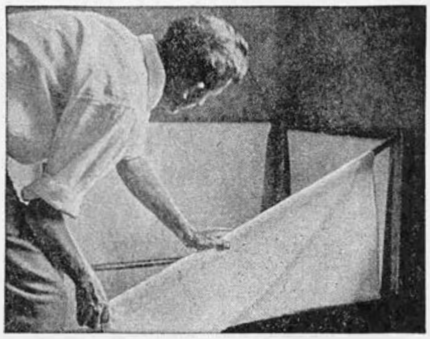




WHEN traveling, you can provide sleeping accommodations for baby by making a portable crib like that illustrated.

Four legs of 2 by 2-in. pine are shaped and bored with ⅞-in. holes as at *A* and *B*, and eight round rails prepared as at *C* and *D*. Two pieces of extra heavy unbleached sheeting, one approximately 25½ by 94 in. and the other about 44 by 75½ in., are cut from 2 2/3 yd. of 72-in. material and strongly sewn with a wide hem at each end. A bag of strong black drill is made to contain the framework while traveling.

To assemble the crib, stand two of the legs (one *A* and one *B*) against the wall with the uppermost holes facing toward you and the lower holes facing each other. Thread one of the short members through the hem on one end of the narrow piece of sheeting and place this member in the inner top holes in the legs. Next place the four long members in the holes in the four legs. Thread another short member through the opposite hem in the sheeting and fit this in the two top holes in the legs away from the wall. The other two short members are then placed in the holes drilled for them in the legs and *inside the sheeting*. The last of these members should be sprung into place. One of the upper long members is then removed, threaded through the hem, and sprung back into place.



To put up the crib takes only a few minutes

MAGIC KNIVES *for* Trick Surgery

Fig. 1. "Look! He's stuck the knife right through his arm!" It's a trick that children watch with amazement

PLUNGING a wicked-looking carving knife through your arm, cutting a playing card in half and yet not injuring it, and making a deep gash in your finger are some of the trick "surgery" stunts you can do with these magic knives. They are not as dangerous as they look, but spectators should be cautioned against raiding the kitchen cutlery department and attempting to duplicate your tricks.

The knives are bought in a department store and doctored with a file, soldering iron, and several scraps of heavy tin. You should do some practicing beforehand in front of a mirror and learn to switch unprepared knives for the trick ones without detection. This is very easy to do, for your spectators will be so startled and dazed it will be easy to distract their attention.

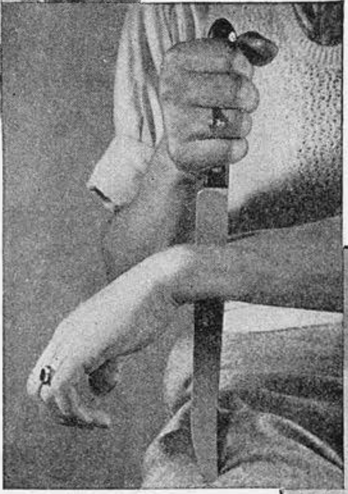


Fig. 2. The knife can be twisted from side to side

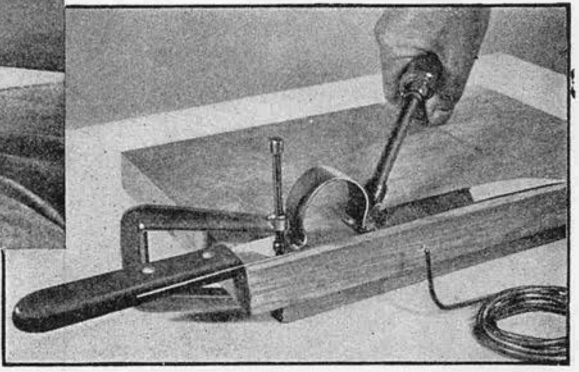


Fig. 3 *(at right)*. Soldering on the U-shaped arm clamp

To all appearances the carving knife shown in Figs. 1 and 2 passes entirely through the arm, and the effect is heightened by twisting it from side to side. You can turn your back when adjusting it on the pretense that the sight might give some spectators heart failure. The knife is tricked by removing a 2-in. section and soldering a U-shaped piece of spring metal in the breach, as in Fig. 3. The breach should be covered with the fingers when exhibiting the knife beforehand, and the spring piece may be painted flesh color.

"Oh how it hurts!"—apparently—to cut your finger as in Fig. 4. Have a duplicate paring knife (they cost ten cents) ready for exchange. The prepared knife has a half-circle space filed out of the cutting edge, as in Fig. 5, and a bit of sponge is soaked with red ink after cementing it to the side that will not be seen. The ink will readily stream from the knife. Be sure to daub some on the duplicate.

The king of clubs is beheaded and the card apparently cut in two in the entirely deceiving trick illustrated in Fig. 6. Hand the card out for examination, and while the audience is wondering how it happens to be whole you can slip off the knife tip. The right-hand photograph of Fig. 6 shows how the knife looks from the rear. A fake 2-in. tip, removed from another and similar knife, slips over the point of the original and is held in place by means of a small piece of tin soldered to the tip. The corners of the tin are bent over, and the tip can be quickly slipped off into the palm of the hand. The illusion is perfect.

Practice these tricks so thoroughly that you can do them automatically while keeping up a stream of amusing and mystifying patter. You have a great advantage over the members of your audience, who do not know what you are going to do, much less how you are going to do it.

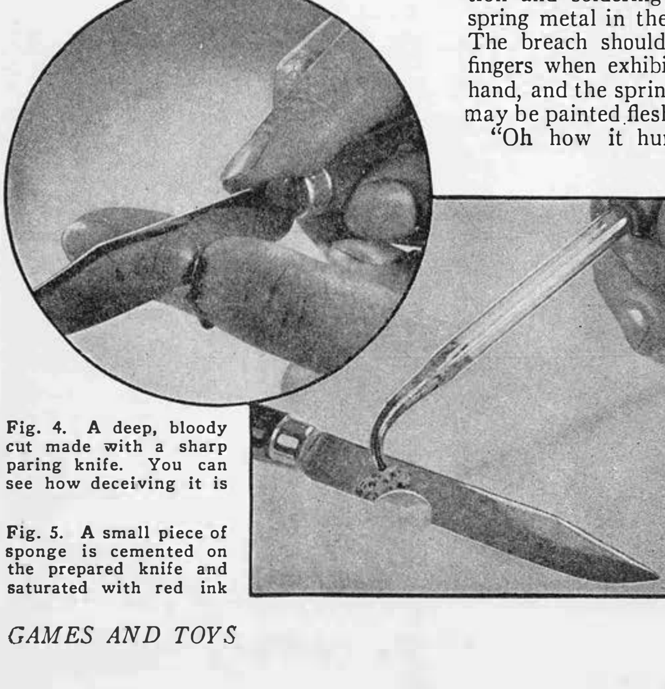
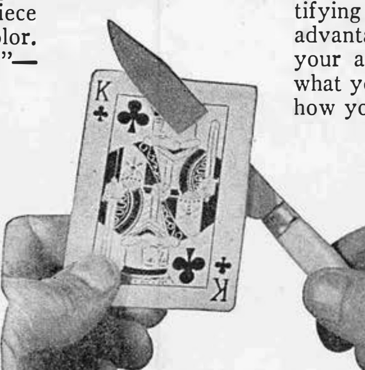


Fig. 4. A deep, bloody cut made with a sharp paring knife. You can see how deceiving it is

Fig. 5. A small piece of sponge is cemented on the prepared knife and saturated with red ink



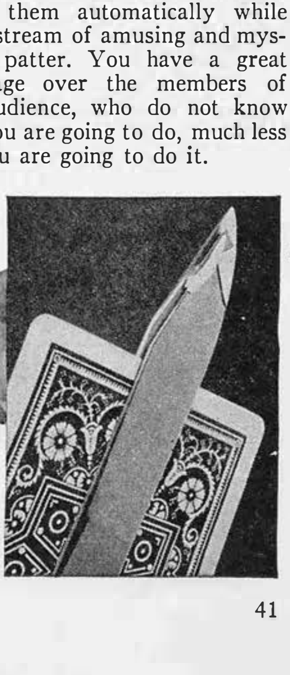
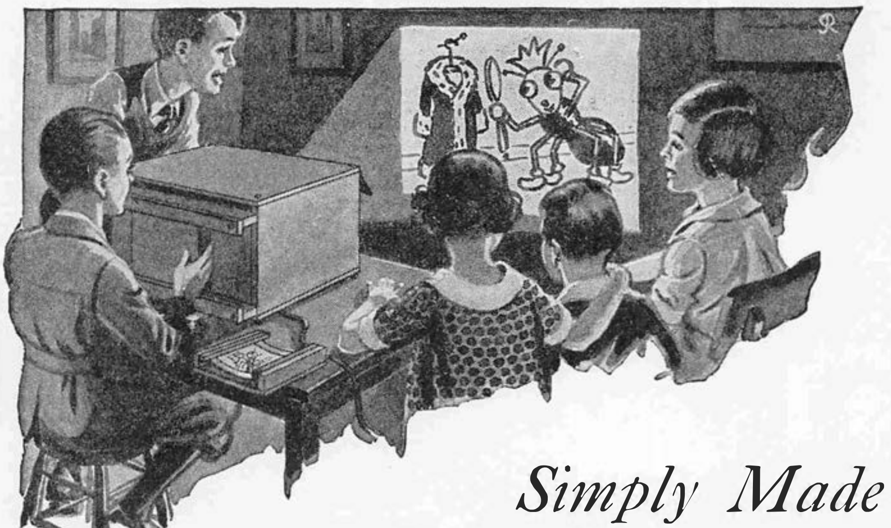
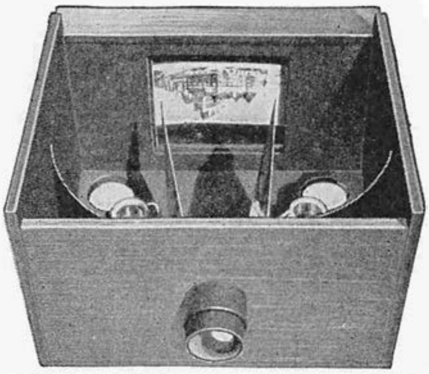


Fig. 6. The king is beheaded with the knife, yet the card is immediately shown to be wholly unharmed. *At right:* The knife has two tips



Simply Made PROJECTOR

THROWS PICTURES ON SCREEN



Projector with top removed. An additional shield or hood is fastened to front of cover

PHOTOGRAPHS and picture post cards can be shown to friends in a more satisfactory and graphic way by throwing them on a screen with a projector like that illustrated.

Almost any lens, such as those used for reading glasses, may be employed. The larger the lens, the clearer the projected picture will be.

The depth of the projection box must correspond to the focal length of the lens. Go to the darkest corner of the room, point the lens toward the window, and move the lens until a clear image of the window is thrown on the wall. Then measure the distance from lens to wall. This is the focal length.

The lens is held in a cardboard tube, which slides inside another cardboard tube. Turn a piece of wood to exactly the same diameter as the lens. Cut a 3-in. wide piece of flexible, smooth-surfaced cardboard, and wrap it tightly around the wooden cylinder. Trim it with a knife until the ends just meet; then paste gummed paper strips over the joint. Square the ends of the tube with a skew chisel, and wrap another strip of cardboard around it, joining the ends on the opposite side. Glue the two tubes together and wrap tightly with a piece of 1-in. bandage. When dry, trim off the ends as before, but let the second layer project 1/16-in. over the first at one end to provide a rabbet in which the lens may be glued. A piece of paper is now wrapped around the first tube, and the second and larger tube is then built up in the same manner on top of the first.

For the box itself, ⅜-in. plywood is best. Bore the hole for the lens holder in the center of the front panel, and the four 2-in. holes in the bottom for ventilation. Also saw the opening for the picture in the rear panel, using a coping saw. The sides, ends, and bottom may now be glued and nailed together.

The pictures are mounted on a slide, which is shown in detail. A fine sawcut is made at an angle in the two sidepieces to hold a thin metal plate (tin will do). The metal should be large enough to curve toward the back. In this way all parts of a picture will be in better focus. The simplest way to hold the pictures against the metal plate, no matter what their size, is with paper clips. A more workmanlike method is shown in the alternative detail. Two small cleats are added to the sidepieces of the slide so that two narrow strips of spring brass may be used to clamp the top and bottom of the pictures.

It is well to make two or three slides so that a helper can mount the pictures, which can then be shown without interruption. The slide is moved across the opening in the back on two runners screwed to the box.

Two porcelain light sockets are now screwed to the bottom and wired, and four rubber-head nails are driven into the bottom for feet.

The metal plates screening the light, as well as the two reflectors, are made and fastened as shown. Thse may all be cut from ordinary tin sheets. With the exception of the two reflectors, however, the tin should be painted a flat black, and also the tubes holding the lens. The interior of the box and the slides should be stained black. A black stain may be made from ½ oz. powdered nigrosine dissolved in ½ pt. denatured alcohol. The outside may be finished as desired.

The painted plates, the reflectors, and the tubes are now remounted in the box. The best lights to use are 200-watt projection lamps, which take up little room and give a strong light. Photographers' flood lamps give good results, but burn only for about two hours. Ordinary 75- or 100-watt lamps may also be used. Clear glass bulbs give more light than frosted ones.

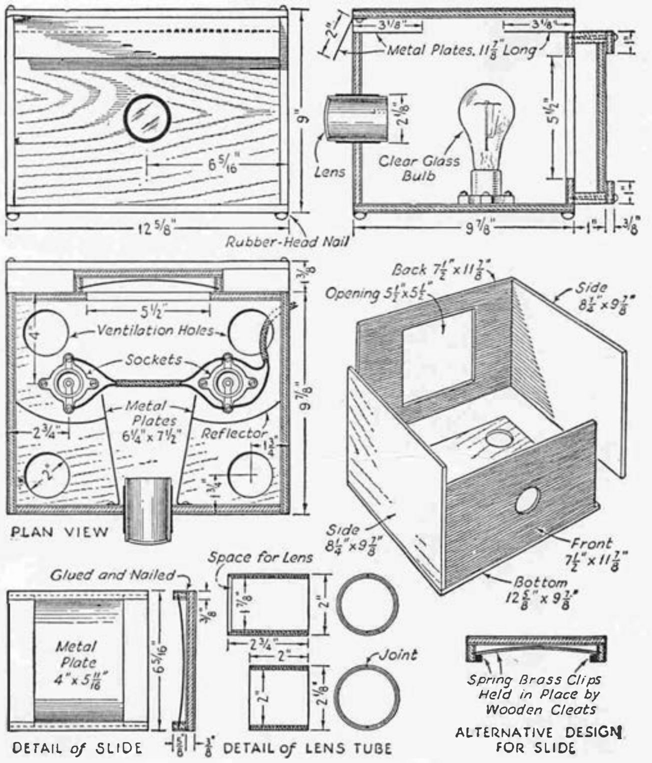
The top is now fastened with screws, the picture mounted upside down, and the box placed about 4 ft. from the screen. A silver-colored screen gives a very clear picture. Move the lens back and forth until the picture is in focus, and proceed with the show.

List of Materials

No. of Pieces	Description	T.	W.	L.
2	Top and bottom	⅜	9⅞	12⅝
2	Sides	⅜	7½	11⅞
2	Ends	⅜	8¼	9⅞
1	Slide	⅜	6-5/16	6-5/16
2	Cleats for slide	⅜	⅝	6-5/16
2	Runners	⅝	1	12⅝
2	Cleats for runners	⅜	1	12⅝
2	Plates (tin)		6¼	7½
2	Plates (tin)		3⅛	11⅞
1	Plate (tin)		2¾	11⅞
1	Plate for slide		4	5-11/16
2	Reflectors		7	7½

Two light sockets and lamps; 10 ft. of lamp cord with plug; lens; 4 rubber-head nails.

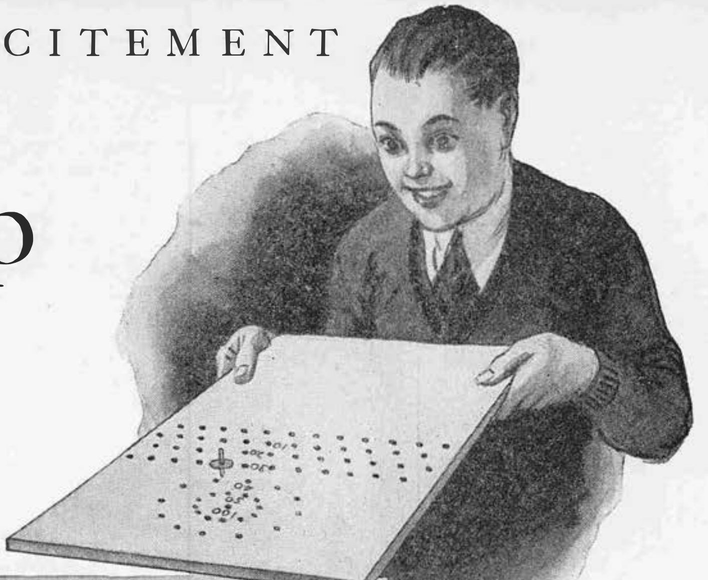
NOTE: Dimensions are in inches and finished sizes.



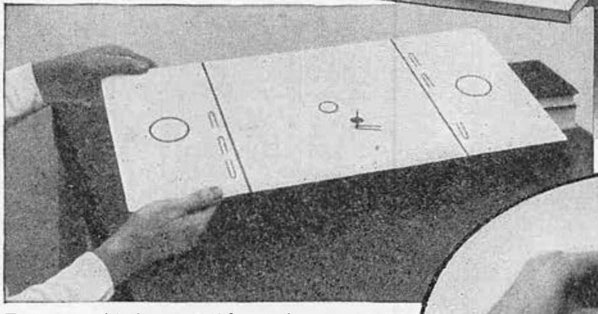
SKILL... LUCK... EXCITEMENT

Combined in New

Walking-Top Game



After spinning the miniature top, you "walk" it along and try to get it into a high-scoring hole

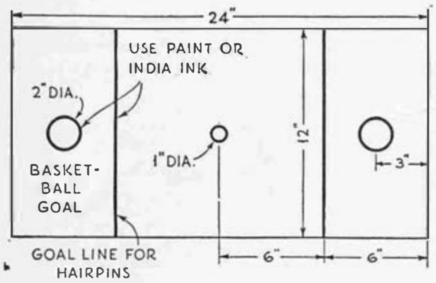


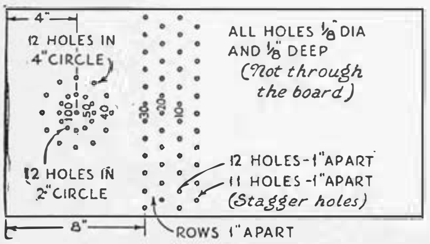
The other side is marked for various games. In this instance, hairpin-shaped wires are being dragged from one goal to the other

HERE is a fascinating new top-spinning game that requires very little equipment. For a playing board, you can use a leaf from a table or a bread board, and one of the small wheels from an old alarm clock will serve as a top.

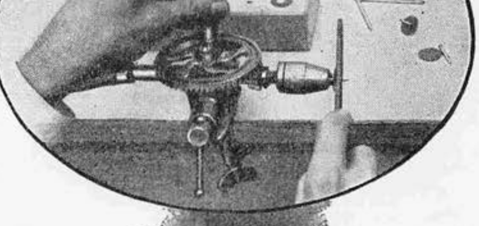
The idea of the game is that you control the "walking" of the top by tilting the playing board in various directions. If you tilt the playing board to the left, the top walks away from you (that is, if you have spun it in a clockwise direction). Tilt the board to the right and the top walks back to you again. Raise your end of the board and it walks to the right, and if you lower it, the top walks to the left. This peculiar walking action of the top and a player's first attempts to control it will cause much amusement.

If you want to make a regular playing board, a good size is 12 by 24 in. Wood, pressed wood, plywood, or even ordinary heavy cardboard may be used. The top spins longer and walks better, of course, if the surface is smooth. A coat of glossy enamel improves the surface, but is not essential. The drawings show how to lay out the board for the various games. Note that the holes in the board for one of the games are only 1/8 in. deep. If the holes are too deep, the top jumps out when the spinning disk touches the board. Some of the accessories are shown in the group of drawings on page 99.



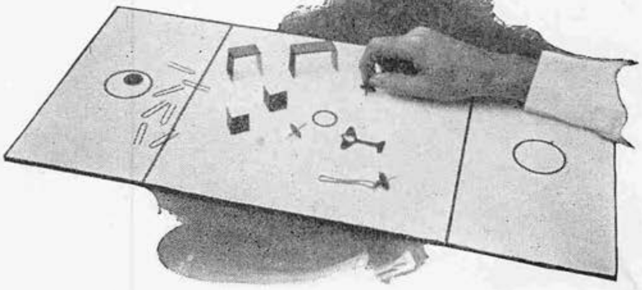

4"
12 HOLES IN 4" CIRCLE
ALL HOLES 1/8" DIA AND 1/8" DEEP (Not through the board)
100
50
40
30
20
10
12 HOLES IN 2" CIRCLE
12 HOLES-1" APART
11 HOLES-1" APART (Stagger holes)
8"
ROWS 1" APART

How to lay out the two sides of the board, which may be wood, cardboard, or composition



Excellent tops may be made by using a drill as a lathe. Note the block used for soldering

While a top made from an alarm-clock wheel will spin and walk very well, you can make a better one from a small piece of brass and an ordinary nail. The dimensions are shown in the drawing. Note the method used for holding the parts in the correct position when soldering. Clean and tin the parts thoroughly before putting them together for soldering. After soldering the top, place it in the chuck of a hand drill, clamp the drill in a vise and, while turning the handle, file off excess solder, sharpen the lower end, and true up the top disk.



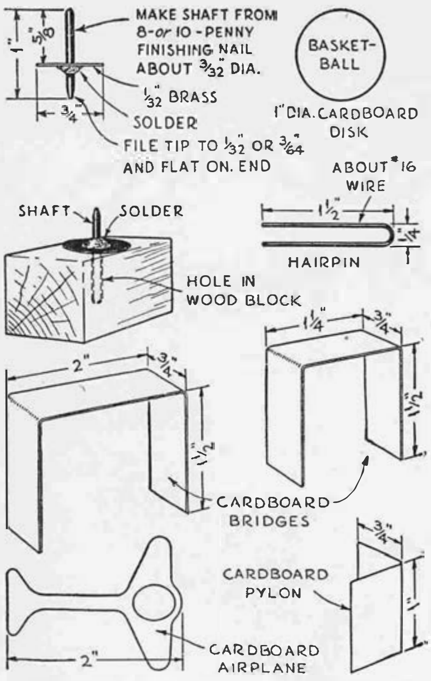
Some of the accessories, including a miniature airplane and pylons

First learn to walk the top to the end of the board and back. Then try walking to the end and around some object and back. Put up two of the folded cardboard pylons or any other small object and see who can make the most laps around them on one spin without touching them. Try a race with the cardboard bridges to go under. Also put up two pylons and see how many figure eights you can make around them.

Children are especially attracted by the little airplane. The top spins in the hole and walks along with the airplane. A rubber band or a loop of string may be moved along in the same way. When coming to a turn, you will find that you can make it sharper if it is made in the direction the top is spinning.

Any one addicted to the now popular marble games should enjoy the game with the numbered holes. There is a lot of chance even if you become an expert at guiding the top. Let each player have three or more turns and see who gets the highest score. The first row with no number counts nothing.

Another game, which might be called "hairpins," is played by placing four of the wire loops behind one heavy black goal line and three behind the other. The player with three loops spins first and tries to walk off with one of his opponent's hairpins. He must take it behind his goal and walk free of it, and then walk off his end of the board. If his top "dies" on the board, he must return the hairpin. He may get a second pin from his opponent if he has enough spin left, but for each time he dies on the board he must return one of the hairpins. The first player getting all of the pins wins the game. When he returns with the last pin, he must release

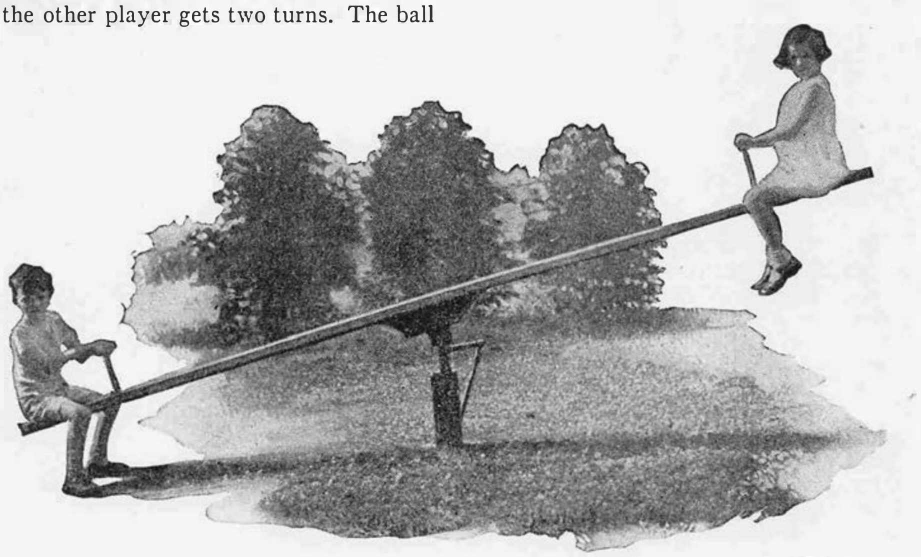


The top, the block used for soldering, and a variety of suggestions for making accessories

it and walk off the end of the board the same as after each other turn. If a pin is walked off the board, it must be returned. The hairpins may be widened into a "V" if the game is found too difficult at first.

In the "basketball" game, the cardboard disk is placed in the center and each player in turn tries to push it into his opponents "basket" (the circle at the end). It must be pushed entirely within the circle. After each turn at pushing the ball, a player must walk back and off the end of the board or the other player gets two turns. The ball goes into play each time where the other player left it.

It is interesting to note how quickly or slowly people learn to control the top because it involves the muscular reactions with which they have been previously unacquainted. In the same way a person learning to drive a car or fly an airplane must develop a new set of reactions.



Children can use this piece of playground equipment either as a teeter totter or a whirligig

Old Auto Parts and Lumber Form This Novel Combination

Whirligig and Teeter-Totter

ALTHOUGH it can be constructed at small cost, this combination teeter totter and whirligig rivals real playground equipment in size and durability and will give children many hours of fun.

The pivot and fulcrum bearing are made from a right-hand front wheel and axle assembly obtained from an auto-wrecking yard. Arrange to have the axle and tie-rod cut at the yard with the cutting torch, about 6 in. toward the center of the axle from the spring mounting. The hub is left intact with the exception that the outer flange is removed. The hub cap should be well packed with grease, which will provide lubrication for a long time if the retainer felts and rings on the spindle are in fair shape.

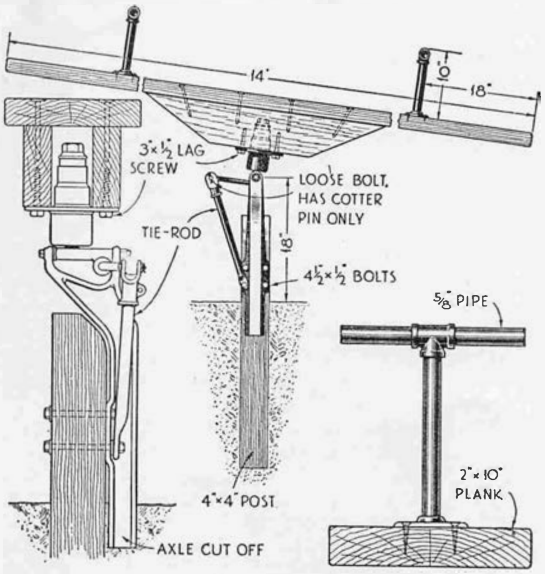
Turn the tie-rod adjusting yoke well down on the tie-rod, and with the center line of the hub lined up with the axle, mark the tie-rod to be cut off so that the end, when flattened and drilled, will fit under the head of the lower bolt of the old spring mounting, as shown in the drawing. Round off the end of the tie-rod after the hole has been drilled, so that the rod will swing clear to fall down out of the way when the bolt holding it to the steering arm is removed. This bolt is held in place only by a cotter pin, and should work freely so that it can be easily slipped in and out.

The axle assembly is then bolted to the upright, which should be a 4 by 4-in. chestnut or yellow pine post about 3½ ft. in length. Set the post, with the axle attached, in the ground to such a depth that the spindle bolt will be about 18 in. above the surface. Tamp earth and small stones firmly around the post to make it rigid, or concrete can be poured around it.

The plank used is 2 by 10-in. yellow pine, selected for grain and soundness, and is 14 ft. long. Carefully round and smooth all edges and corners. To strengthen the plank, two 2 by 4-in. or 2 by 6-in. pieces, each 3 ft. long and cut to the bevel shown, are spiked on edge to the underside of the plank at its center. These are spaced so as to allow the hub to fit between them, and are attached to the inner hub flange, on which they rest, with 3 by ½-in. lag screws. Handholds made from ⅝-in. pipe and fittings as shown should be placed about 18 in. from each end of the plank. Use 1½-in. screws through the pipe floor flange and into the plank, making certain that the flanges are securely fastened to the plank.

To adjust the pitch of the plank, merely turn off the yoke on the end of the tie-rod until the lower end of the plank will be close enough to the ground for a child to reach it easily with his feet in order to propel it as a whirligig. After it has been started, it can be kept in motion by bending forward or back as in "pumping" a swing. It will not take the child long to learn to lean forward as the end upon which he is sitting swings around to go up, and to lean back just as it starts to swing down. In this manner it is possible for one child alone on the plank to make it revolve at considerable speed with no difficulty at all.

To use it as a teeter totter, pull out the bolt holding the tie-rod to the steering arm, and let the tie-rod fall down out of the way. It will be found that in using it as a teeter, the plank will need to be kept about at right angles to the spindle in order to avoid the tipping sideways that would otherwise occur.

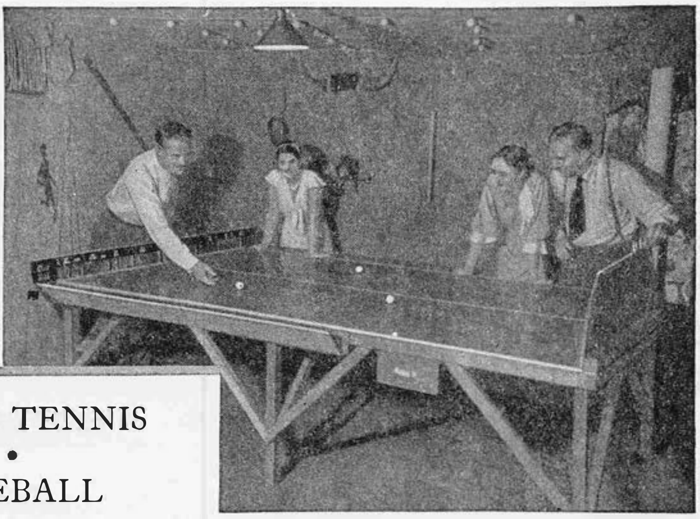


How the apparatus is set up for use as a whirligig. To convert it into a teeter totter, the tie-rod is released

Seven-*in*-One Table

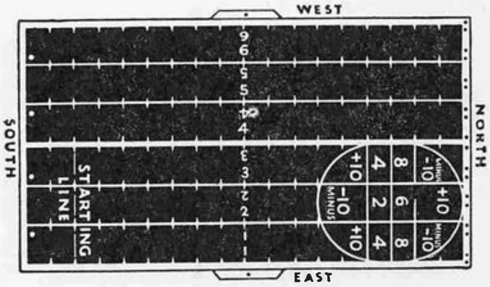
PROVIDES GAMES FOR ALL

SEVEN different games can be played on this unique homemade table tennis or ping-pong table. It is a standard 5 by 9 ft. table to which a net can be fastened for table tennis, but there are additional lines and numbers inscribed on the surface, and various attachments and accessories are provided for the other games—baseball, bowling, shuffleboard, flick, bounce, and horse race.



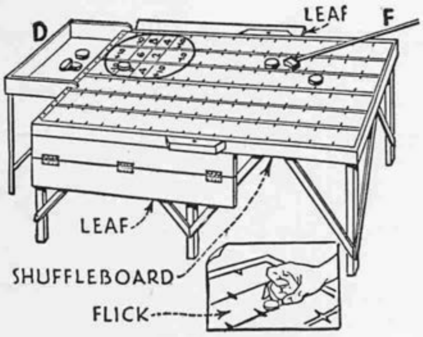
Playing baseball. The score for a nine-inning game rarely exceeds four or five runs because of the ingenious system followed

TABLE TENNIS
•
BASEBALL
•
BOWLING
•
SHUFFLEBOARD
•
FLICK
•
BOUNCE
•
HORSE RACE



The top painted for shuffleboard and horse race. The east half is used for shuffleboard

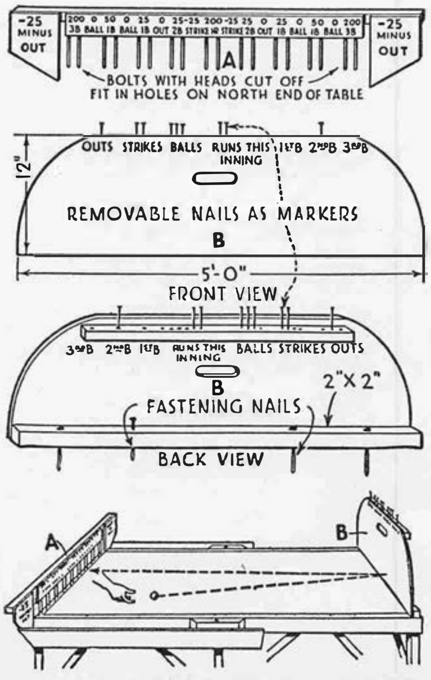
To use the table as a miniature shuffleboard, the net is removed and the leaf on the east side (the sides being marked north, east, south, and west for ready reference) is hooked into active position to catch disks that slide off the side of the table. Then the tray marked *D*, which is 18 by 36 in., is placed at the north end to receive the overshots that would otherwise slide onto the floor. The east lengthwise half of the table is all that is required for the alley. On the north end of this east half is painted the usual shuffleboard diagram. Six 2-in. wooden disks painted red and six black ones are pushed from the line at the south end by means of the pushers *F*. These are 36 in. long. Alternating, each of the two players pushes a disk from the starting line into the diagram until all twelve disks have been disposed of. Tally is then computed by totaling those disks which are free and clear of lines. The score is carried and compounded from inning to inning for as many innings as have been prearranged.



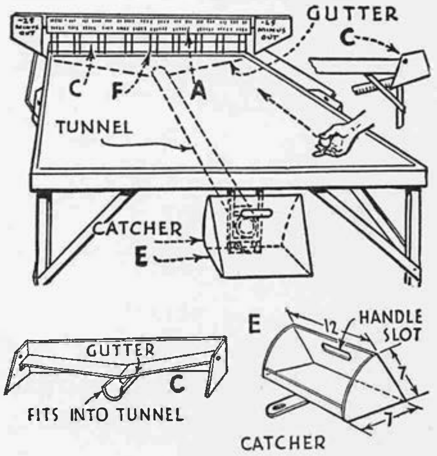
For both shuffleboard and flick, the east leaf is raised and accessory *D* is hooked on

Flick is played under the same rules and in the same diagram except that checkers are used instead of disks. These are shot down the table by snapping the middle finger off the thumb. As many players may take part as there are different colored checkers; or, teaming up, each team member may use three checkers.

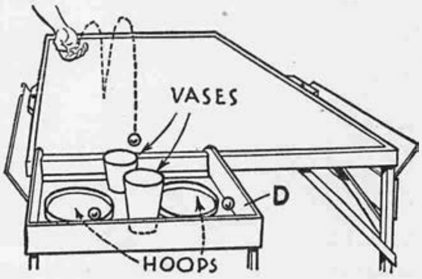
The third game is bounce. In that same tray *D* used in the two previous games is spread a piece of cloth folded to form several thicknesses. On this pad are placed two small hoops, and between the hoops two vases of different heights, one behind the other. The tin vases used by florists or the type of receptacles used to mix frosted drinks at a soda fountain

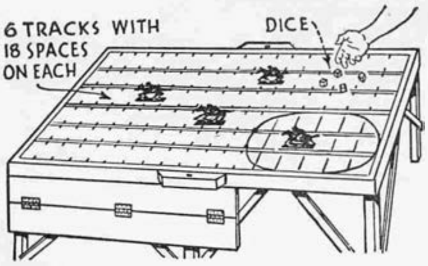

-25 MINUS OUT
200 0 50 0 25 0 25 -25 200 -25 25 0 25 0 50 0 200
3B BALL 1B BALL 1B OUT 2B STRIKE HR STRIKE 2B OUT 1B BALL 1B BALL 3B
-25 MINUS OUT
A
BOLTS WITH HEADS CUT OFF FIT IN HOLES ON NORTH END OF TABLE
12"
OUTS STRIKES BALLS RUNS THIS INNING 1ST B 2ND B 3RD B
REMOVABLE NAILS AS MARKERS
B
5'-0"
FRONT VIEW
3RD B 2ND B 1ST B RUNS THIS INNING BALLS STRIKES OUTS
B
FASTENING NAILS
2"X 2"
BACK VIEW
A
B

Accessory *A*, which is used for baseball and bowling; back and front views of accessory *B*; and the way they are placed for baseball



The table arranged for bowling and sketches of accessory *C* and catcher *E*, used for returning balls. *Below:* Set-up for bounce




6 TRACKS WITH 18 SPACES ON EACH
DICE

A horse race on four of the six long tracks. The first horse up and down the table wins

are especially suitable. Six table tennis balls are then tossed from the south end of the table so that they will, on their first or second bounce, land in a vase or a hoop. The score is 25 points for each hoop, 100 points for the small vase, and 200 for the large one, and 25 is deducted for each ball that goes out of bounds.

Now for that good old American game, baseball. Fasten accessory *B* on the south end with its front facing north. Adjust accessory *A* on the north end, and see that the other drop leaf is hooked into place on the west side. Take several heavy table-tennis balls or, better still, inflated rubber balls of equal size. The player at bat stands at the north end and rolls the first ball along the table to hit the wall *B* at the south end, off which it rebounds to the north end where it registers as indicated by lower figures on accessory *A*. The two triangular extensions of *A* stop stray balls from rolling out of the side troughs.

Balls remaining on the table count as foul strikes and are left there until the batter either is retired or reaches a base. Another ball is then used and if the second ball should touch the first, the batter is out as well as any batters on base. In other words, this is a double play. Of course, three strikes retires the batter, four balls walks him, and three out retires the player.

The inactive player uses nails or long pegs to indicate the status of the side at bat by putting nails in the holes at the back of accessory *B*. At a glance the batter can see how many strikes and balls are on him, how many outs, men on bases, if any, and so on. Not unlike a good baseball game, the scores rarely exceed four or five runs in a nine-inning game.

For the bowling game accessory *C* is also attached at the north end and the baseball wall *B* is removed from the south. *C* forms a gutter into which the balls drop as they are bowled from the south end. The balls then roll into the tunnel under the table and are deposited in the receptacle at the south end of the tube. Again the ping-pong balls are used, as many as you have. A few red balls counting double add to the interest of this game. The upper numbers on accessory *A* are scored for this game.

The sixth game is similar to the horse race of shipboard fame. The table is ruled off for six lengthwise tracks, and these are divided as shown to give eighteen moves. Each player takes a horse and selects a track (numbered in the center of the table). The players then roll four dice and as many times as a player's number appears, he moves his steed forward. He also takes another roll every time his number appears.

Table tennis itself, of course, needs no explanation. It is the seventh game.

MAKING PLASTER SET SLOWLY

In mixing plaster it is useful to have on hand a saturated solution of tartaric acid. One drop added to each glass of water used for mixing the plaster will delay it from setting for from one to two hours.

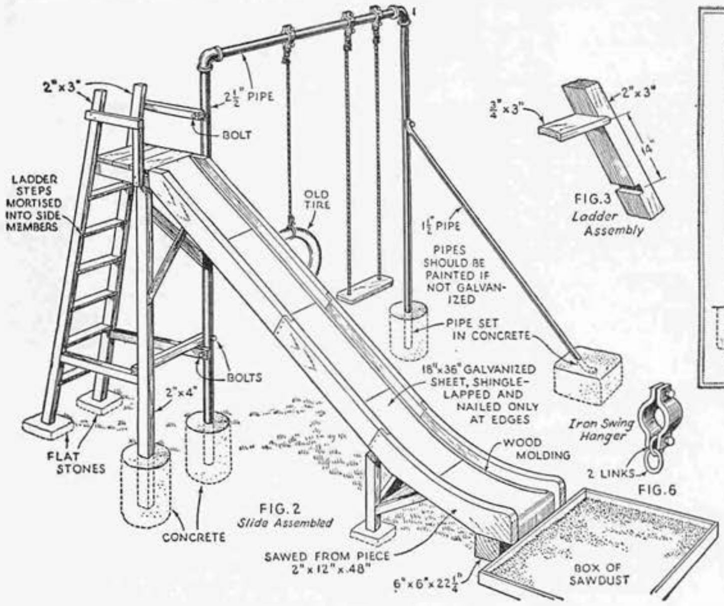

2"x3"
2½" PIPE
BOLT
LADDER STEPS MORTISED INTO SIDE MEMBERS
OLD TIRE
1½" PIPE
PIPES SHOULD BE PAINTED IF NOT GALVANIZED
PIPE SET IN CONCRETE
18"x36" GALVANIZED SHEET, SHINGLE-LAPPED AND NAILED ONLY AT EDGES
BOLTS
2"x4"
FLAT STONES
CONCRETE
WOOD MOLDING
SAWED FROM PIECE 2"x12"x48"
6"x6"x22¼"
BOX OF SAWDUST
3/4"x3"
2"x3"
14"
Iron Swing Hanger
2 LINKS

FIG.2 *Slide Assembled*

FIG.3 *Ladder Assembly*

FIG.6

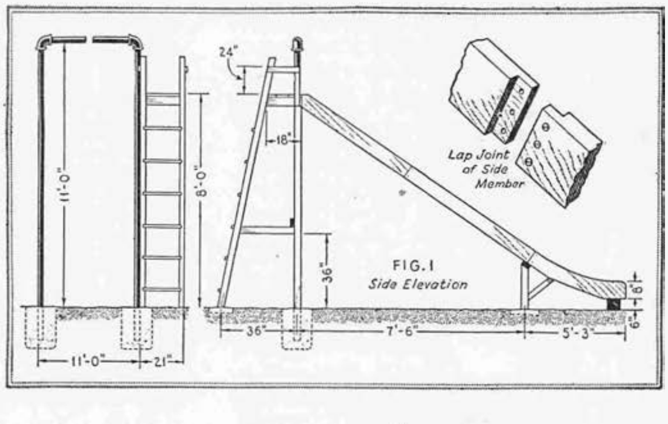


FIG.1 *Side Elevation*

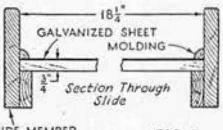
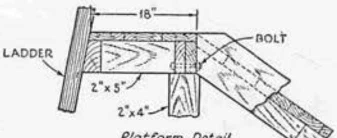
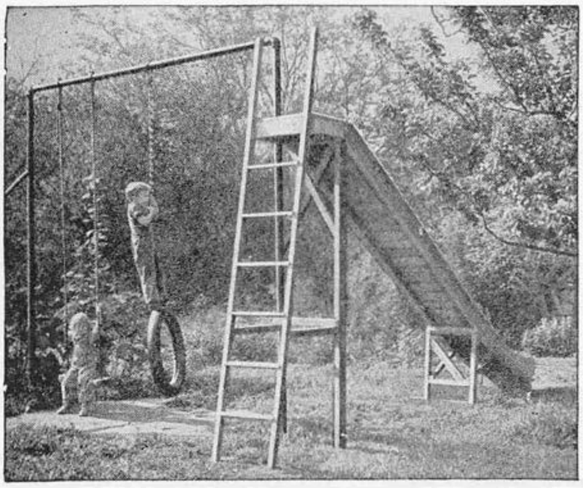


FIG.4



Platform Detail FIG.5

Back-Yard Playground Built at Low Cost



This homemade playground keeps the children off the street

Scrap materials picked up at minimum cost were used to a large extent in building the compact playground equipment illustrated at the left and shown in detail above. The principal exceptions were the galvanized sheets and side members of the slide, for which new materials were bought.

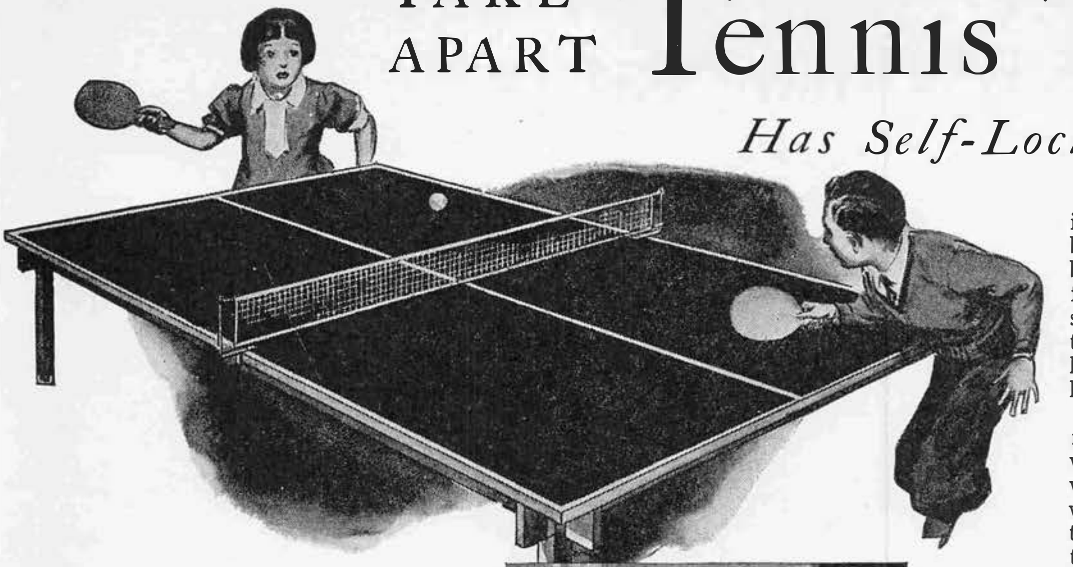
As can be seen by the dimensions given in Fig. 1, the equipment requires comparatively little space and can be erected in any spare corner of the back yard. The perspective drawing, Fig. 2, shows how to go about building it. Note that the uprights and iron pipe are set in concrete, but this is not absolutely necessary. If the wood below ground is creosoted, it will last almost indefinitely. The pipe, if not galvanized, should be protected with paint.

First build the ladder by the method shown in Fig. 3, and assemble with the pipe and 2- by 4-in. upright supporting the platform. Note that the ladder steps are mortised into the side members. This is not absolutely necessary, but makes a better job. The slide can be built upon the ground and erected later. The construction is given in Fig. 4. The side members are lap-jointed as shown in a perspective sketch. Molding is nailed over the edges of the galvanized sheets, which are laid overlapping, shingle fashion. The lap should not be nailed.

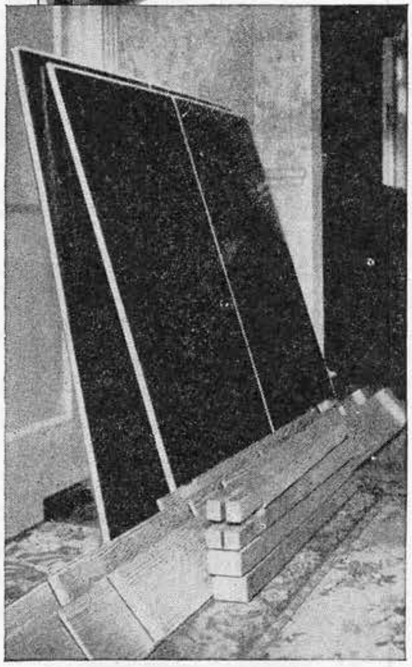
When completed, the side is joined to the platform as shown in Fig. 5, with bolts through the cross members at the joint.

TAKE-APART Tennis Table

Has Self-Locking Joints



After the game is finished, this table can be taken apart in a few minutes and stored away. Unassembled, the parts appear as at the right



SIMPLICITY of design and an unusual assembly make this table-tennis table especially practicable to build for home use. It may be assembled or completely taken apart in a very short time without the use of any hardware or fastenings to hold the parts in place. The joints are self-locking and resemble to some extent a mortise and tenon. When apart, the table can be stored in a comparatively small space. A table such as this, of course, might be put to a number of uses besides the game of table tennis.

Because it was to be placed in a comparatively small room, the table illustrated was made 4 by 7 ft., but a friend of the author, following the same plans, built one the regulation size, 5 by 9 ft. For the convenience of those who wish the standard table, the dimensions for a 5 by 9-ft. table have been placed in parentheses on the drawing. Where only one dimension is given, it is the same for either size table.

The table top is made of two halves, each 3 ft. 6 in. long by 4 ft. wide, or 4 ft. 6 in. long by 5 ft. wide, as the case may be. The material is three-ply wood ⅜ in. thick. Large plywood dealers usually stock it in the special 5-ft. width required for tennis tables.

On one end of each of the table-top halves is fastened a wooden batten ¾ by 1¾ in. by 4 ft. long (or 5 ft. in the case of the larger table). On the underside of each of these battens is secured two ½ by 1 by 1-in. stop blocks. These battens and blocks may be fastened with small brads, screws, or glue.

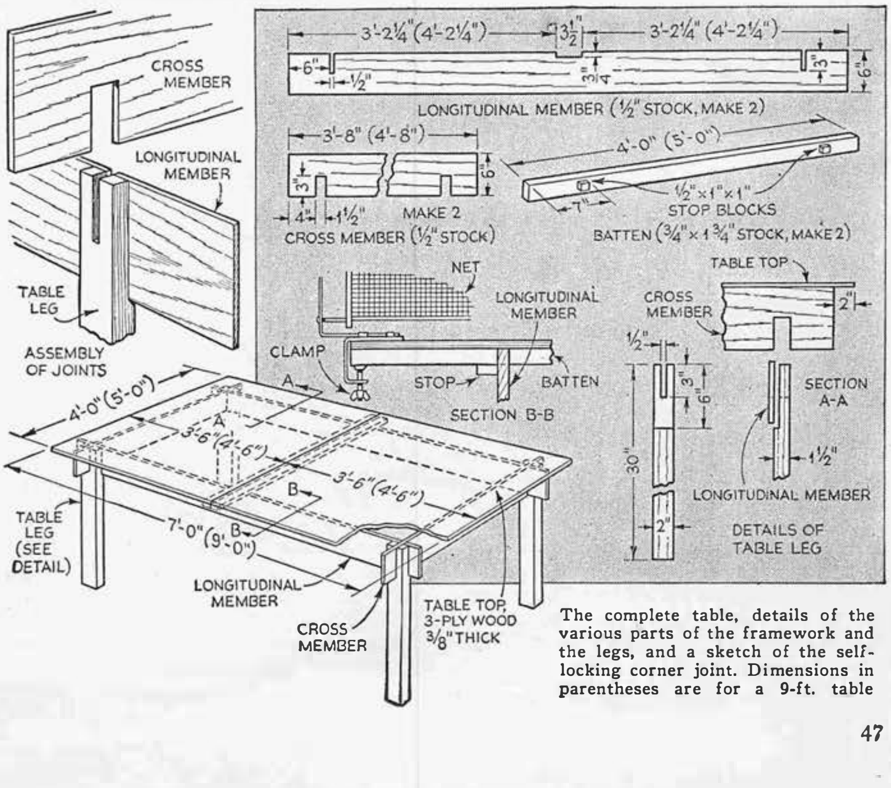
There are two long rails ½ by 6 in. by 6 ft. 8 in. (or 8 ft. 8 in. for the larger table), with three notches in each, cut to the dimensions shown. The two cross rails are ½ by 6 in. by 3 ft. 8 in. (or 4 ft. 8 in.), with two notches in each as detailed. The four legs are 1½ by 2 in. by 2 ft. 6 in., notched for the cross members and dadoed ½ in. deep for the longitudinal pieces.

The section marked *A-A* shows the way in which the legs, cross members, and longitudinal members fit snugly together to form a sturdy joint; and *B-B* shows how the center of the table top fits into the notched longitudinal members and is held by the small stop blocks.

If the table is stained, varnished, rubbed down, and then waxed, the finished product will be one of which you may well be proud. The painted line through the central length of the table must be applied, of course, before any waxing is done. Locate the center of each end of the table. Chalk a piece of twine somewhat longer than the table length, secure the string to the predetermined centers, draw the string taut, then lift the twine a few inches over the center of the table and let go with a snap. The whitened twine will leave a straight line. If your hand is steady, it is a simple matter to paint a white line along the chalk mark, but to make it easier, you may fasten two lengths of masking tape on the table top on each side of the chalk line, allowing a space of about ¾ in. between them. Then paint in the space, and after the paint is dry, remove the tape.

The table-tennis net, which is standard equipment obtainable at any sporting store, is clamped as shown in section *B-B*.

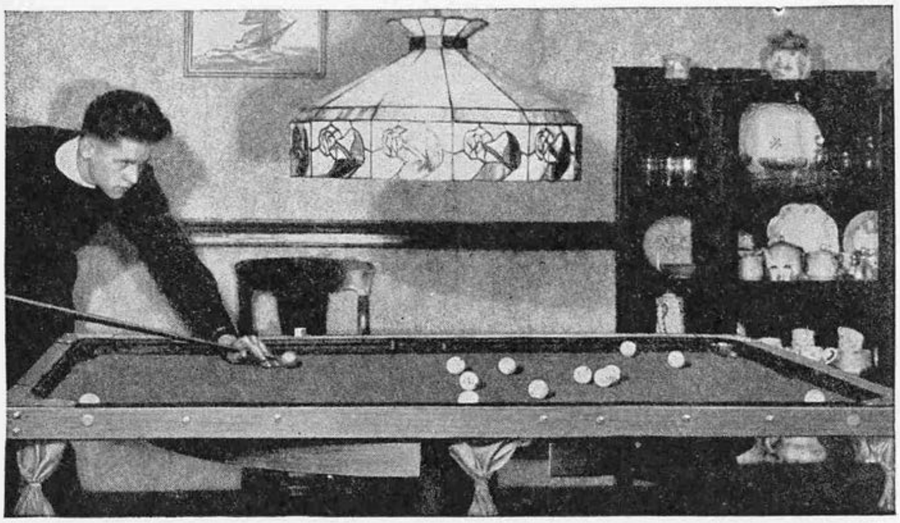
By following the same construction, a bridge table can be made. The same legs will serve, but the top should be about 3 ft. square. If very light plywood is used for the bridge-table top, it may be covered with a waste piece of linoleum. No covering is used on a table-tennis table.

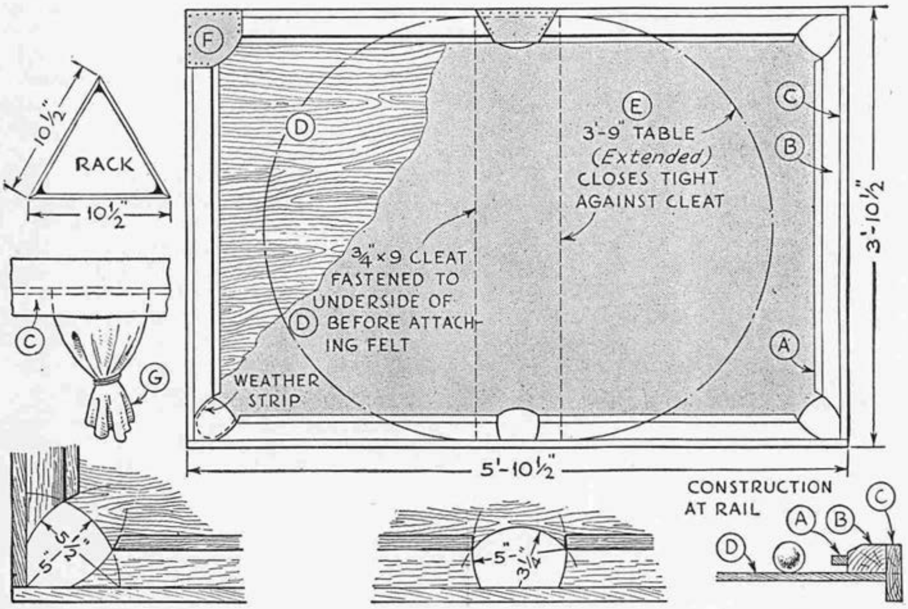


The complete table, details of the various parts of the framework and the legs, and a sketch of the self-locking corner joint. Dimensions in parentheses are for a 9-ft. table

Golf-Ball Pool Table

Can be set up on any large dining-room table—Rubber cushions are not required




F
D
E
3'-9" TABLE (Extended) CLOSES TIGHT AGAINST CLEAT
C
B
¾"×9 CLEAT FASTENED TO UNDERSIDE OF D BEFORE ATTACHING FELT
A
WEATHER STRIP
RACK
10½"
10½"
C
G
3'-10½"
5'-10½"
5½"
5"
5"
3¼"
CONSTRUCTION AT RAIL
A
B
C
D

How the golf-ball pool table is constructed and used. It has a cleat on the underside that fits between the opened halves of an ordinary round dining-room table. The cushions marked *A* are of hardwood instead of rubber, and the playing surface is covered with an old blanket

A FAST and accurate game of pool can be played with golf balls on the homemade table top illustrated above. It is inexpensive and easy to construct, has no rubber cushions to deteriorate, and requires only an average size dining room or kitchen for space.

The original top, which has a playing surface 3 ft. 5 in. by 5 ft. 5 in., was built to suit a dining-room table 3 ft. 9 in. in diameter. If your table is a different size or shape the dimensions must be altered, but the same construction of rail and pocket can be followed.

The parts marked *A* are ½ by ¾-in. hardwood; *B*, 1½ by 2-in. pine; *C*, ¾ by 3-in. pine; and *D*, ⅜-in. plywood. The dining-room table is represented by a dot-and-dash line and marked *E*. The felt is indicated as *F*, and the felt pockets as *G*.

Fasten *A*, *B*, and *C* to the plywood first, mitering *A* and *B* at the corners and gluing and screwing all securely. Then to mark the pockets, either trace around a template made from sketches or lay them out with a compass directly on the wood. Saw down through *A*, *B*, and *D* to form holes for the pockets. The cushion at *A* should be of hardwood and not more than ¾ in. above the plywood.

The cleat underneath should be at least ¾ in. thick and 9 in. wide. It is attached with flathead screws, down through *D* and up through *B*.

An old blanket dyed green makes an excellent bed. Attach the cloth to *D* with either linoleum paste or automobile running-board cement. Be sure to roll out all wrinkles. Slash the cloth at the pockets and glue it up underneath. Use the same material for pockets, having them sewed up in the form of sleeves about 8 in. in diameter and 10 in. long. Tack one end under each hole, and tie the other end 2 in. from the bottom.

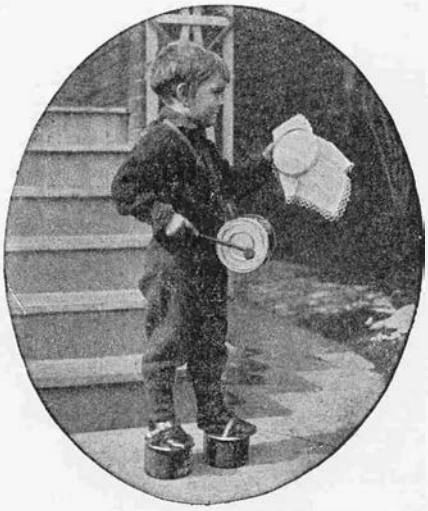
A piece of padded weather strip tacked in the pockets directly opposite *A* and pieces of green cloth tacked across the top of the pockets will kill all rebound of the balls at the pockets. Angle irons in the corners will help stiffen the table and make it more durable.

All exposed wood should be sanded and stained dark red. Add two coats of wax or varnish, and you have a pool table to be proud of.

At a sporting goods or chain store, you can buy practice golf balls, often for as little as ten cents each. Get sixteen of these and stain one black or red to be used as a cue ball.

An easy way to make a strong rack of ¼ by 1-in. hardwood is to build it around a triangle made of 1-in. wood, each side being 9½ in. long. Glue and brad the corners only, and when the glue is dry, cut away the centerpiece to leave the rack as shown in the drawing.

You will probably want three or four cues. Make these of any straight-grained hard wood 4 ft. long and tapering from 1¼ in. straight down to ½ in. at the tip. Sand these well, stain any dark color, and add leather tips, which you can buy for a few cents from any pool-supply dealer.



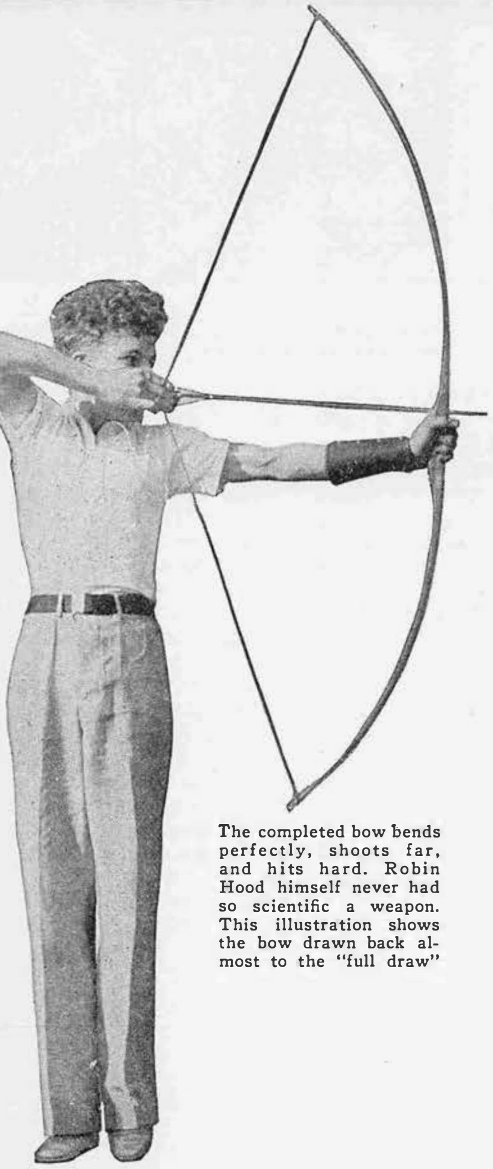
VARIETY OF TOYS MADE FROM COFFEE CANS

A CAN opener and some straps are all that are required to turn empty coffee cans into toys. A drum is made by cutting two slots in the side of a can to take a neck band, as shown. The clackers or can-walkers are prepared by making two slots diametrically opposed in the bottom of a can to receive the strap for the foot.

The false rims inside coffee cans make excellent toy embroidery hoops without alteration.

OUTDOOR SPORTS

Now you can shoot THE NEW American Flat Bow



The completed bow bends perfectly, shoots far, and hits hard. Robin Hood himself never had so scientific a weapon. This illustration shows the bow drawn back almost to the "full draw"

Bows are among the oldest weapons in the world, yet an amazing thing was only recently discovered about them. Through mathematical analysis, laboratory investigation, high-speed photography, and painstaking field tests, it was found that the famous English long bow, after which practically all target bows are patterned, does not have the most efficient shape. Its beautifully rounded limbs are a delight to the eye, but the best cross section for a bow is something much simpler—just a plain rectangle. This discovery led to the development of the modern American flat bow, one easily made variety of which is described here.

WHEN the white man provided the American Indian with a cheap trade musket in place of his native bow and arrow, he saved himself a good deal of grief, for had the red man developed his weapon along a logical path he might have arrived at an approximation of the bow we now know as the "semi-Indian," "flat," or "American" bow. With such a bow he could have shot with accuracy at a hundred yards (about the extreme accurate range of the long rifle), and could have delivered arrows faster than any frontier scout could load his rifle.

Any home workman, equipped with ordinary tools, can readily build the most modern and most efficient bow yet designed. The best material for the amateur is the imported wood known as "lemonwood." It can be worked almost entirely by measurement, without much regard to the grain. California yew and Osage orange probably make a better bow, but not for the inexperienced builder.

Lemonwood can be had from most dealers in archery supplies, either in the rough stave or cut to approximate outline. The price ranges from about $1.75 to $3. In ordering you should be careful to say you need a wide stave for a flat bow.

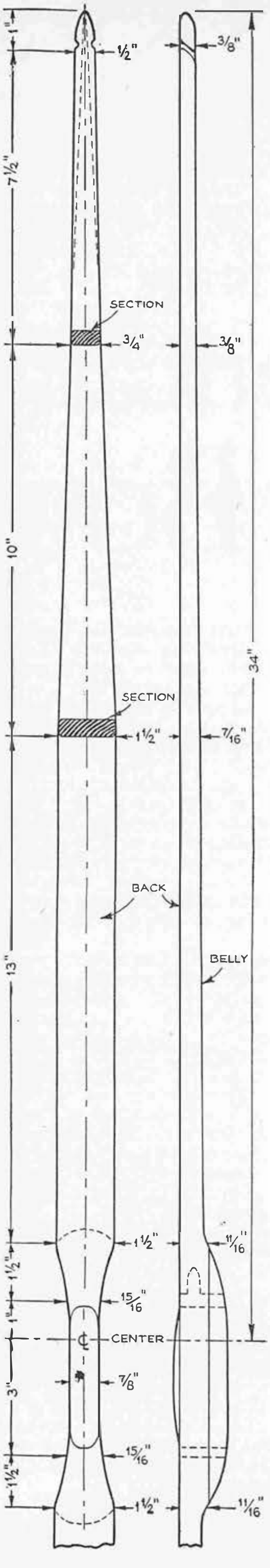
The dimensions given are for a bow 5 ft. 8 in. long with a weight (the archer's term for the strength of a bow) of from 45 to 50 lb. at a draw of from 27 to 28 in. This combination is suitable for the average man. When new the bow will draw 5 lb. or more above these figures. For clearness, only the upper limb of the bow is shown on the drawings. The lower limb is similar but slightly stronger. It should be 7/16 by 1½ in. at a point 14¼ in. below the center line; ⅜ by ¾ in. at a point 24¾ in. below the center; and ⅜ by 9/16 in. (instead of ⅜ by ½ in.) at a point 1 in. from the very end.

The stave, as it comes from the dealer, has been shellacked or varnished to prevent checking. Remove this coating from the back—the side away from the archer as the bow is held in position to shoot. Plane and sandpaper the wood just enough to provide a smooth surface. Stretch a fine piece of unkinked copper wire tightly down the center line of the stave, mark dots at regular intervals, and connect the dots, using a long T-square or other straightedge and a sharp, hard pencil.

Lay out cross lines as shown on the drawing and mark the widths by dots. Connect these dots with straight lines, giving a rough idea of the back of the bow. Since the sharp shoulders and angles are unsightly, change them free-hand to graceful curves along one side, then trace paper templates in order to reproduce the curves on the opposite side.

With drawknife, spokeshave, and finally a pocketknife or scraper and garnet paper, work to the lines marked on the back, keeping the cuts at right angles to the surface of the back.

Run straight lines along the edges of the stave from the center

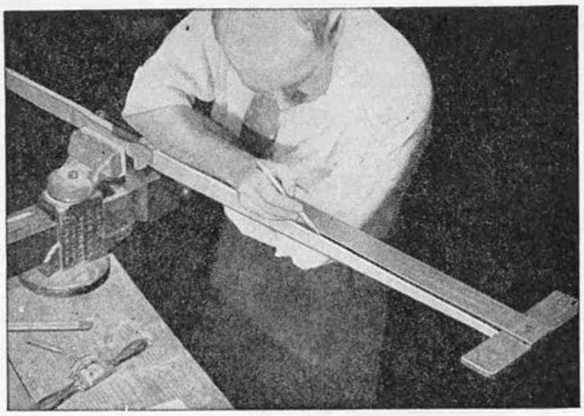


out to the tips to mark the thickness of the bow, following the dimensions on the drawing. Both edges of the stave should be marked. Now mark the profile of the riser at the grip, dipping it boldly into the run of the belly at each side of the handle. If the stave did not come with a piece glued on to form the handle, you will, of course, have to cut a suitable block of hardwood about ½ by 1 by 8 in. and glue it on.

Set the bow in the vise, belly up, and shave off the wood above the lines just drawn. For the deeper part of the cut near the tips, a drawknife may be used with caution; but nearer the handle where the cut is shallow, a spokeshave and small block plane are safer. When the bow has been worked to a rectangular cross section over its whole length, except at the riser, which is rounded, you are ready to test it for curve.

This work has probably consumed an evening, and you are obliged to lay the bow away until you have more spare time. Before you do so, rub the whole bow with shellac to prevent any possible checking or absorption of water.

You now need what is known as a "tiller" for testing the bow, as well as a temporary or working bowstring and a shooting tab for protecting the fingers. The tiller is a piece of scrap wood about ⅞ by 3 by 30 in., notched at 2- or 3-in. intervals as shown to catch the bowstring and notched at one end to fit over the handle of the bow. As the tiller may be used later on the finished handle, it is just as well to pad the end jaw with leather. The tiller serves to hold the bow bent for inspection during construction and, as it will be used often, should be carefully and accurately made.



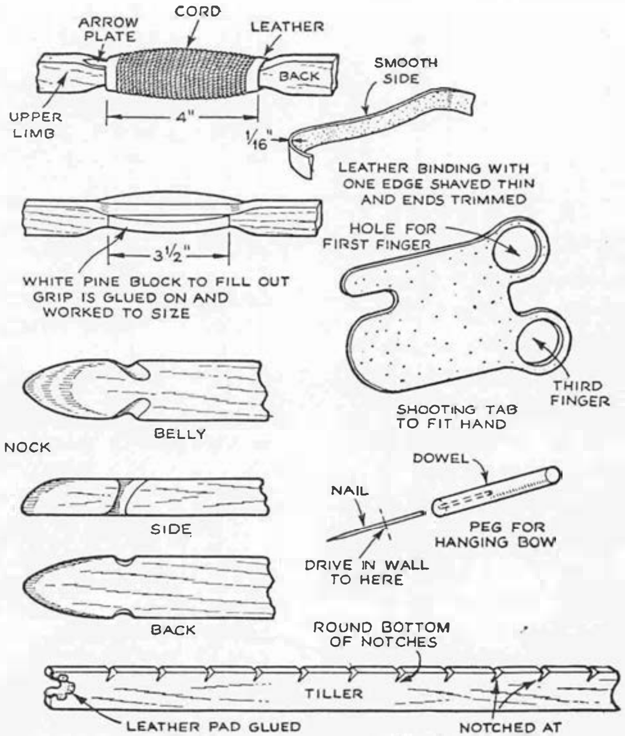
Using an old T-square to mark the lines showing the height of the belly of the bow. The vise is faced with removable wooden jaws

The string for tillering must be far stronger than the one ultimately used for shooting—at least 60 strands of No. 20 linen thread. Lay up twenty strands 18 in. longer than the bow, stretch them smoothly, and wax them together. Make two more sets and tie the three together. With the tied ends over a hook twist each of the three groups of thread individually to the right and have an assistant hold the twist in. Now take all three and lay them round each other to the left, as if making rope. The right-hand twist makes them grip one another and cling together. Put the string under tension and rub thoroughly with beeswax. Work it round and compact by rubbing with a small piece of leather held between the fingers. Tie a permanent loop (bowline) at one end and use a timber hitch to fasten the lower end to the bow.

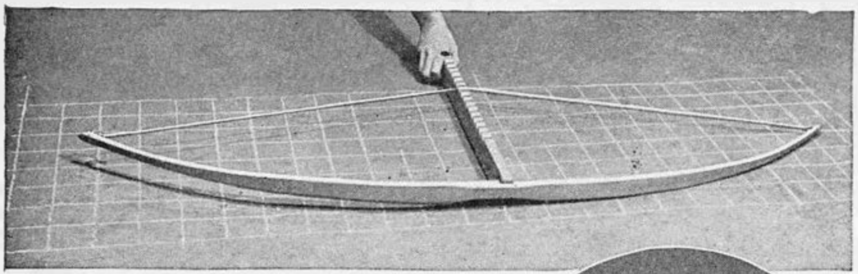
Later you will need a shooting string, and because a breaking string endangers not only the bow but the archer and bystanders as well, it is better for a beginner to buy a few strings. When one of these becomes frayed, take it apart, study the make-up, read a bit on the subject, and try to make one yourself. You will soon be able to produce a creditable string.

The notches at the ends of the bow, or "nocks" as an archer calls them, are best put in with a small round file. At the side, near the back, the nocks are half round, slanting across the side toward the grip and flaring slightly to give room for the string to change direction as the bow is drawn. They should not extend across the back of the bow as this would seriously weaken the bow tip.

Slip the loop down over the upper tip, draw the string down the bow, and fasten it at the lower nock with a timber hitch. Have the string about 3 in. shorter than the length of the bow, that is, measuring from nock to nock.



At left are the back and side views of the upper limb and handle of the flat bow. Above are sketches showing how the handle and nocks are finished and how a shooting tab, tiller, and peg are made



Testing the curve of the tillered bow on a grid-iron chalked on the floor. ***In circle:*** **Using a spokeshave to cut the belly down to guide lines**

Place the bow in the vise and have an assistant pull carefully on the lower tip while you pull the upper and slip the loop in place in the nock. Do not push on the limbs, for a breaking bow nearly always throws splinters forward with murderous force. The string is likely to stretch considerably, and you will have to adjust the timber hitch several times before you hold the bow bent to any great depth.

As soon as you have a bend of some 5 or six in. in the bow, place the tiller on the handle and hold the bow, back down, on the floor, steadying it with your toes. Then pull the string up a few notches on the tiller with both hands. Have your assistant ready with a piece of chalk to mark any section which does not bend evenly, for the whole bow must contribute to the shot to obtain the utmost efficiency.

Let the bow down, unbrace it—that is, slip the loop out of the upper nock—and replace in the vise for scraping at the spots marked by the chalk. To make sure that the whole section is reduced evenly, rub the part to be scraped with soft pencil lead. By scraping the marks away, you remove a thin layer of wood and will not risk reducing one side more than the other.

Flat bows bend in a different arc than ordinary long bows—practically a perfect arc, slightly flattened in the center opposite the grip. So slight is this flattening that the radius of the curve of each limb should be the same as the length of the draw—in this case 28 in. If a template like that on the following page is laid on the floor and the bow worked down carefully until it fits neatly within the arcs, you are practically sure to produce a bow which will give flat trajectory, good distance, and little jar. Do not keep the bow at full draw more than a few seconds at a time.

Generally speaking, the bend should show first in the center of the limbs, then in toward the grip, and lastly in the third of the limbs nearest the tips. Allowing the tips to bend too early in the work weakens them excessively and produces what are known as "whip ends."

Finally the corners of the limbs are rounded slightly to lessen the danger of denting. Draw a line 1/16 in. each side of the back corners and 3/32 in. from the belly corners and round only to these lines. Sand with No. 6/0 garnet paper until fairly smooth and rub on a good coat of shellac.

The bow is now ready to shoot for the first time. Although it is not essential, a good practice in breaking in a new bow is to select arrows considerably heavier than those to be used later. If heavy arrows are available, use them for about 200 shots, as this works the bow down without permitting it to recoil too sharply. Birch hunting arrows ⅜ in. in diameter are about the right weight for this purpose; otherwise use cheap birch target arrows. They can be obtained from archery dealers or sporting goods stores for so little that it hardly pays to attempt to make them. Besides the shooting tab to protect the fingers, an arm guard or "bracer" is needed to prevent the bowstring from bruising the left forearm. The conventional bracer is made of heavy leather, but a piece of fiber or thin, narrow strip of hardwood may be tied on to serve the purpose.

Now tiller the bow again. It will have lost weight and changed shape slightly, and will need further correction.

Glue on a thin piece of white pine to round out the back of the bow. Taper it in gracefully to meet the back of the bow, and round it into the sides. A serviceable grip is made by serving the bow with crab line, chalk line, or braided trolling line. The total length of the grip should be about 4 in., the winding occupying 3¼ in. of this space and the balance being covered by leather circlets. The upper circlet has a projection at the left of the bow; this serves as an arrow plate and prevents arrows from wearing the wood as they leave the bow. Use rather thick leather so it may be whittled away from the underside to a thickness equal to the string binding. The outer edge is trimmed to a feather edge and the ends thinned to make a neat joint; then the leather is dampened, glue coated, and bound in place with narrow strips of cloth until dry. As soon as the leather is dry, shellac the whole handle. The cord may then be painted as suits the bowyer's fancy, and another coat of shellac applied to protect the color.

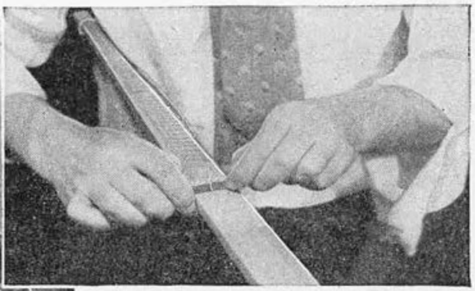
Plush, velvet, leather, and gimp braid are also used to pad handles, but cord affords a firm grip and is very durable.

Once the new bow has been well tested and has proved itself satisfactory it should be cleaned carefully. Remove all tool marks and thoroughly sand it with the finest garnet paper. Thin some white shellac about fifty percent with alcohol, turn a little on a soft, lintless cotton cloth, and rub the bow briskly until the shellac has dried and a surface begins to show. It will be necessary to work a short section at a time and to go over the whole bow several times to build up a shellac surface. Smooth lightly with very fine paper or steel wool and rub with furniture or piano polish until a dull gloss finish results. This method builds up a surface so thin that it will not crack with bending, yet thoroughly water resistant and beautiful to the eye. A bow carefully waxed and polished after each field day soon takes on a fine luster, and the surface becomes toughened.

If, after a month or so of regular shooting, the bow is found too strong for comfort, it can be reduced to suit.

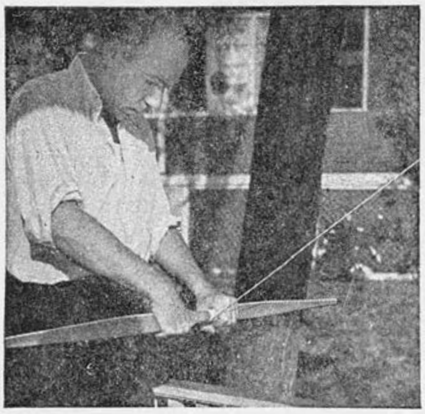
So far as the making of various types of arrows, bowstrings, bracers, quivers, targets, and other archery tackle is concerned, there are several excellent handbooks and a variety of booklets that give detailed information.

Keep the bow unbraced when not in use. Hang it from a peg or lay it on a shelf or across a pair of pegs supporting the middle third of the bow. A good bow rack can be made by driving sharp-pointed finishing nails from which the heads have been



Slight reductions are made with the blade of a penknife or a steel scraper. The wood is first marked with soft pencil so no spots will be overlooked

Especial care and delicacy are required in trimming down the tips or ends of the limbs where the bow is narrow. The best safeguard is to test the bend frequently by using the tiller



Wrapping the grip with crab line. The line is clove-hitched to a convenient nail or hook

clipped part way into a plaster wall and slipping over them dowels in which a hole has been bored. The holes in the dowels should be a close fit. If the nails are driven at a slight upward angle and the dowels are cut to fit the wall closely, the effect will be that of wooden pins set in the plaster. If the nails alone were used, the iron would corrode and leave unsightly marks on the bow.

A SHELF, too narrow to accumulate other impedimenta and with a raised edge, makes an excellent place to lay a bow. It can be provided with a backboard bearing pegs for hanging other tackle.

If you must keep your bow in a steam-heated apartment during the winter, place it in the coolest dry room. Hot, dry heat soon makes a bow brittle. When storing the bow, wrap it from end to end in a strip of woolen cloth, such as an old spiral legging before slipping it into a bow case. It should be inspected from time to time, warmed occasionally, and strung and bent at intervals during the off season. In short, it should have about the same consideration that you give your rifle or your golf equipment.

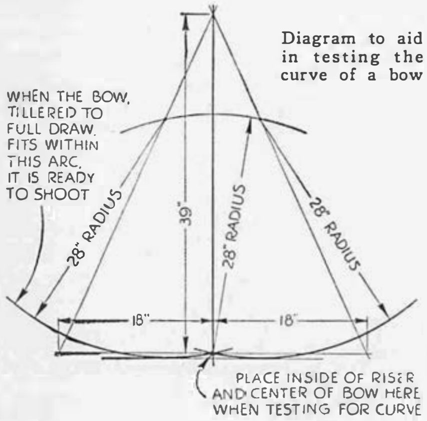
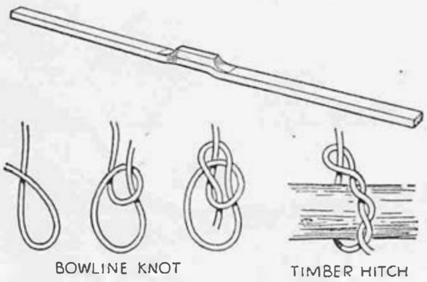


Diagram to aid in testing the curve of a bow

WHEN THE BOW, TILLERED TO FULL DRAW, FITS WITHIN THIS ARC, IT IS READY TO SHOOT
28" RADIUS
28" RADIUS
28" RADIUS
39"
18"
18"
PLACE INSIDE OF RISER AND CENTER OF BOW HERE WHEN TESTING FOR CURVE



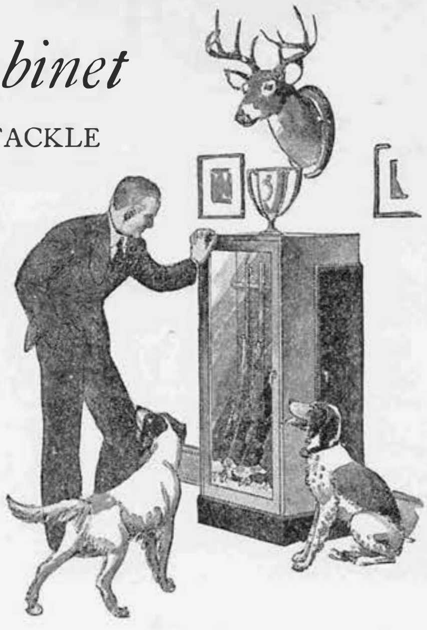
A flat bow stave with handle riser glued on, as purchased from dealer; and the knots used at upper and lower ends of the bowstring

Sportsman's Cabinet

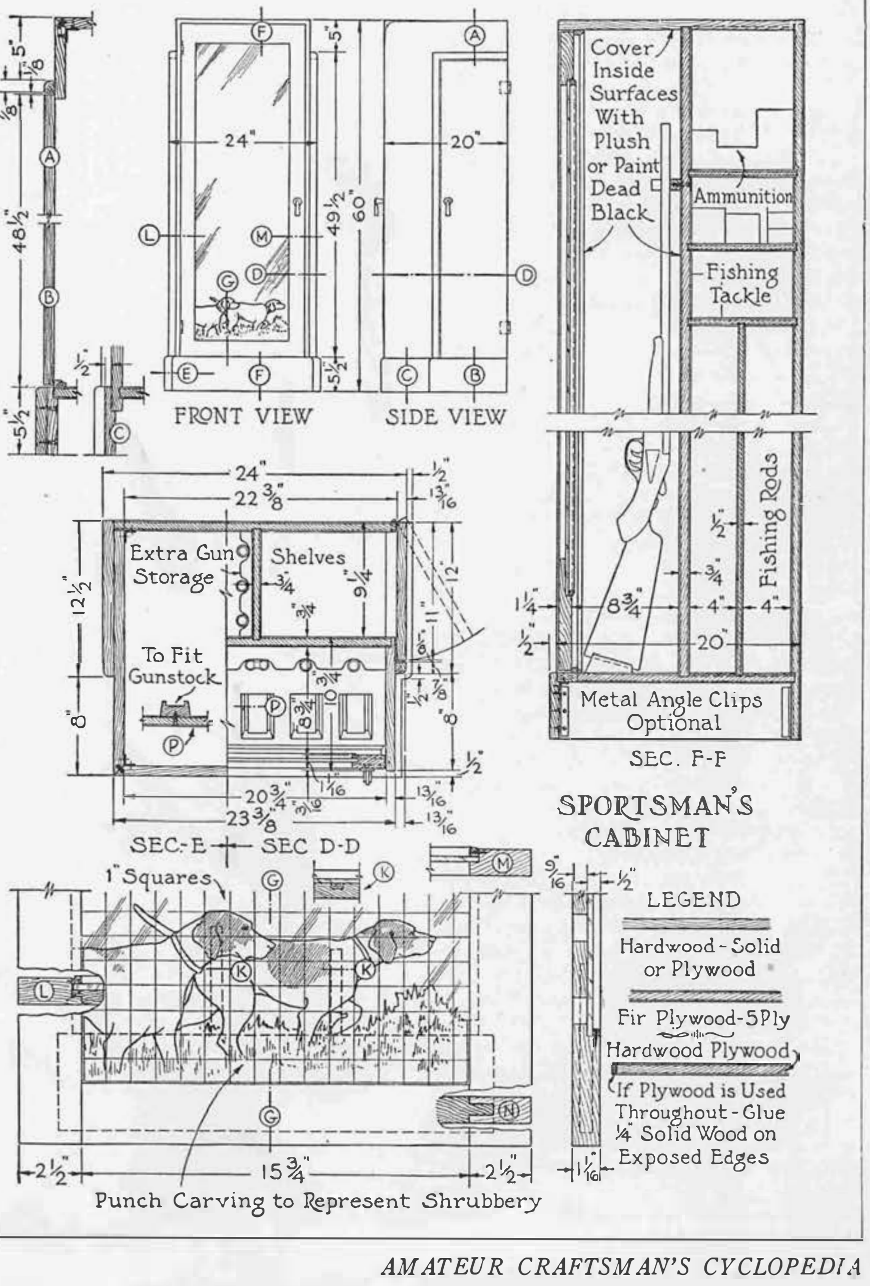
HOLDS GUNS AND FISHING TACKLE

WOODWORKERS who also like to hunt and fish will get double enjoyment in constructing this unusually attractive and practical cabinet. There is ample room in front, behind the glass door, for the display of five guns, and additional room is provided in the back for the storage of other firearms, as well as compartments for fishing rods and tackle, ammunition, and other accessories.

The extensive use of plywood in this design allows the construction to be kept relatively simple. The dog silhouettes, which are lightly carved, provide a touch of decoration that relieves the otherwise severely plain case. Detail *K* shows how wood inserts are made to strengthen the silhouettes. Choose the plywood with an eye to a distinctive grain pattern, and apply a good finish.



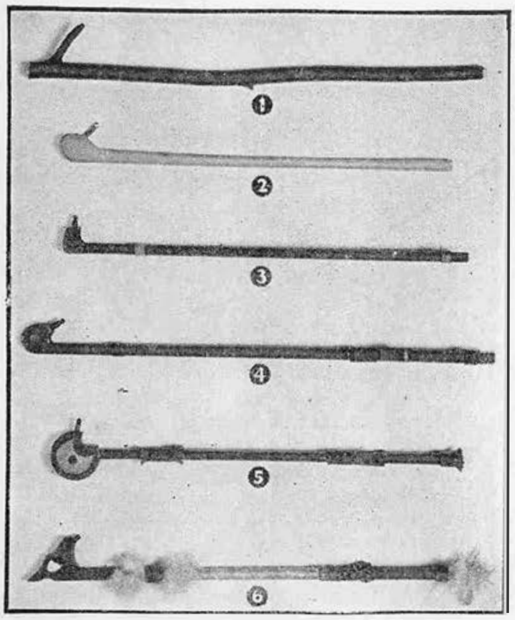
Doors at each side give access to storage compartments hidden behind the main gun rack



TARGET PRACTICE WITH

Mayan Throwing Sticks

How to make equipment for a novel outdoor sport . . . Arrows are hurled with the aid of a curious ancient weapon instead of being shot



THROWING STICKS Six suggested designs. Lengths may vary from 20 to 27 in., and the pegs can be set at any angle from 45 to 80 deg. The first is merely a branch of a tree; the second and third are almost as simple; but the remaining three are carefully made

HERE is a fascinating sport that requires little equipment and is quickly mastered—hurling arrows at a target with a homemade hul-che, or Indian throwing stick.

The hul-che was one of the weapons used by the ancient Mayas in Yucatan and other parts of Mexico and Central America. It is merely a stick with a protruding head or peg, which engages the end of an arrow. By means of the stick, the arrow can be thrown great distances with surprising force and accuracy. Unlimited skill may be gained by practice; the exercise is a healthful one; and the sport becomes highly competitive when engaged in by a group.

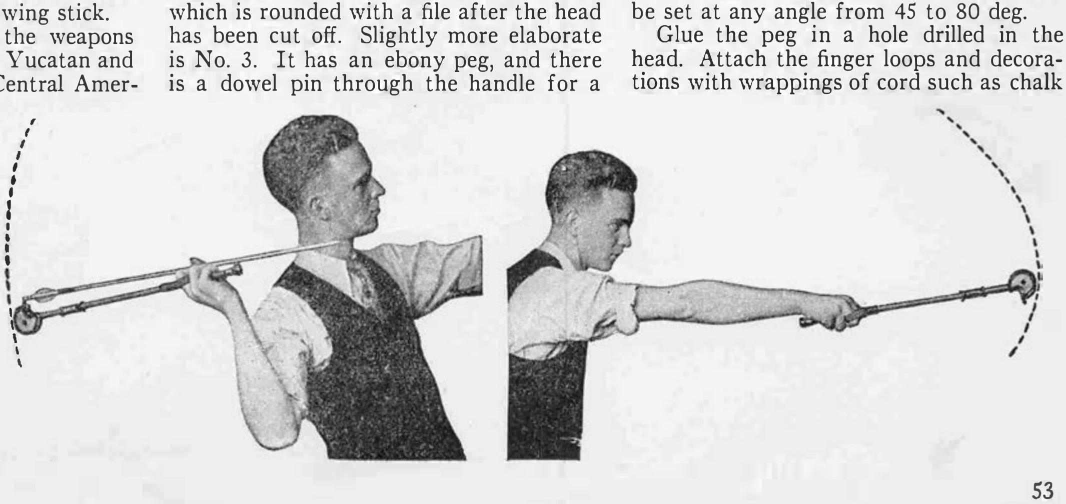
The sticks illustrated are not copies of authentic Mayan designs, but represent a few of the many types that may easily be fashioned.

In the photograph at the left, showing a group of six sticks, No. 1 is made from the forked limb of a tree. The smaller branch is burned off to harden and round it so that it serves as a peg. The second stick is whittled from white pine, and the peg is a wood screw, which is rounded with a file after the head has been cut off. Slightly more elaborate is No. 3. It has an ebony peg, and there is a dowel pin through the handle for a finger rest. Cord is wrapped around the stick in two places for decoration.

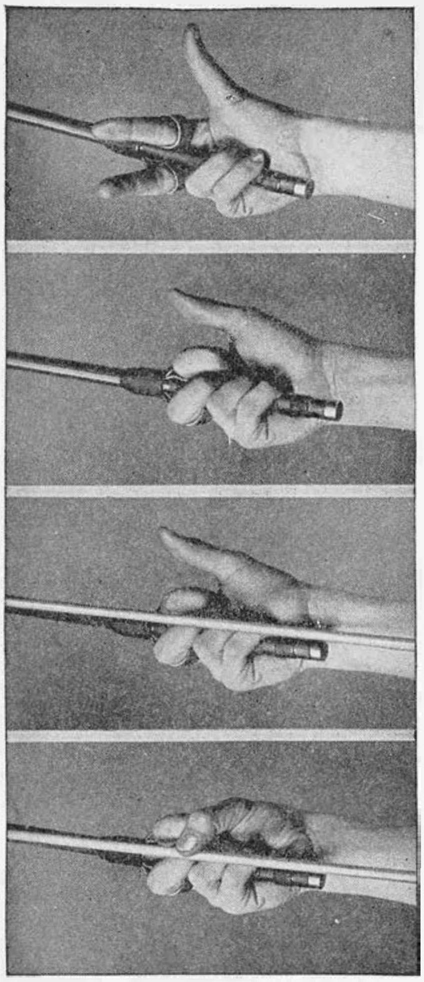
Still better are the sticks marked Nos. 4, 5, and 6. These are made of maple and have turned ebony, bone, or maple pegs. They are painted in various colors and decorated with cord wrappings, leather fringes, and feathers, and have leather loops for the fingers. All three sticks can be cut from a piece of maple ⅝ by 3 by 30 in., as shown in the accompanying diagram. The stock for the handles is ⅝ in. square. The heads may be cut to any desired design and the handles rounded off and dressed down to about ½ in. round. The sticks are then sanded, stained, and polished.

The peg in each case is about ¼ in. in diameter, with a ball formed on the end. A ball will follow the concave socket in the arrow through a greater length of stroke than a plain, straight point. The peg may be set at any angle from 45 to 80 deg.

Glue the peg in a hole drilled in the head. Attach the finger loops and decorations with wrappings of cord such as chalk



Beginning and end of the throwing stroke are shown at the right



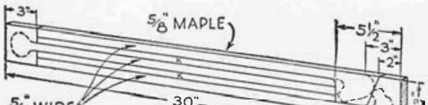
Method of grasping the stick and placing the arrow, which is held lightly with the thumb

line. Pull the ends through under the wrappings to avoid knots. The wrappings may be stained with water colors and shellacked when dry.

Although arrows from 28 in. to 5 ft. in length may be used, the standard 28-in. target or hunting arrows obtainable at any sporting-goods store are probably the most practical. It is necessary merely to cut off the nock and form a round concave socket to match the rounded end of the peg. If you wish to make your own arrows, you will find instructions in any standard book on archery.

The method of gripping the stick is illustrated in the accompanying series of four photographs. The second, third, and fourth fingers grasp the handle, while the first finger is folded up out of the way. Place the arrow socket on the peg and lay the shaft along the first joint of the second finger, holding the shaft in place with the thumb. Use only enough pressure to keep it from falling off.

Stand with the feet apart, the left foot forward and pointing toward the target, the right foot back and at right angles to the left, unless, of course, you are a left-handed thrower, in which case the position is reversed.



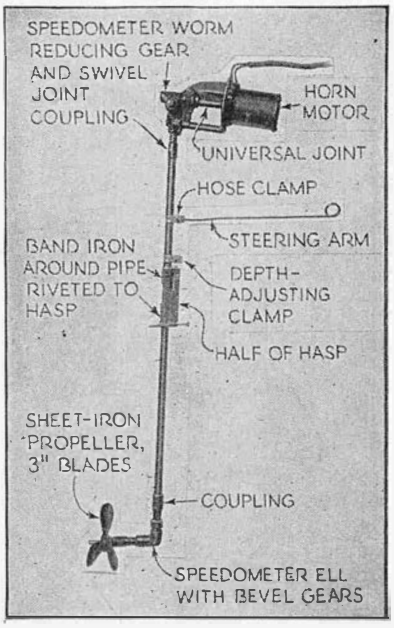
An economical way to cut three sticks from one small piece of maple or other hardwood

Draw the stick with the arrow in place straight back over the shoulder and execute a straightforward overhand swing. At the finish of the stroke, rock up on the right toes. Do not try to release the arrow with the thumb, as it is not necessary. If the thumb is pressed lightly against the arrow, but not lapped entirely over the top, the release will take place without conscious effort and at exactly the right time.

The throwing stick is by no means a toy. It has a range up to 500 ft., and the power is sufficient to inflict serious injuries. Use the same precautions as with archery. Be especially sure to have plenty of room when you first try out the sport. An archery target is the most convenient to use, but any type of target in which the arrows will stick may be used.

Do not allow children to use the throwing sticks unless under adult supervision. If you regard it as a weapon and use reasonable care, you will find it quite safe and will soon develop considerable accuracy. Continued practice will bring greater skill and increasing enjoyment in this unique and healthful sport.

HORN MOTOR PROPELS BOAT FOR FISHING

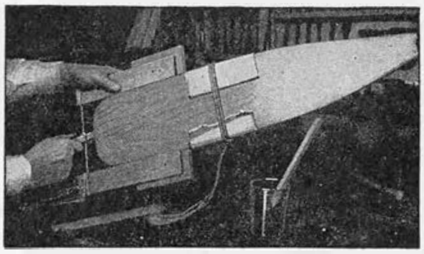

SPEEDOMETER WORM REDUCING GEAR AND SWIVEL JOINT COUPLING
HORN MOTOR
UNIVERSAL JOINT
HOSE CLAMP
STEERING ARM
BAND IRON AROUND PIPE RIVETED TO HASP
DEPTH-ADJUSTING CLAMP
HALF OF HASP
SHEET-IRON PROPELLER, 3" BLADES
COUPLING
SPEEDOMETER ELL WITH BEVEL GEARS

A photograph of the propelling unit with all the principal parts lettered for identification

THIS electric outboard motor has been in use for several years on a 14-ft. boat from which trout or bass are caught in various small lakes or ponds. It is driven by a 6-volt auto battery and is so quiet and smooth that one can slip right up on the old boys. It weighs only 7¾ lb. without the storage battery. The boat can be steered from any position by attaching a cord to the steering lever. The cord runs through screw eyes fastened in the sides of the boat. The propeller is adjustable as to depth, and can be turned completely around in relation to the motor.

The outfit is made from an old auto horn, old speedometer parts, tubing, band iron or sheet iron, a hinged hasp, bolts, and screws. A 20-penny nail fastens the two parts of the hasp together. The part of the hasp not shown is, of course, attached to the stern of the boat.

GLUING SPLIT PADDLES AND OTHER THIN WOOD



An improvised clamp for gluing split wooden parts such as the blade of an oar or paddle

CLAMPING a thin piece of wood for gluing so that it will not warp is always difficult. If the thin piece is a split canoe paddle or the blade of an oar, and you are without the usual tools, it seems next to impossible.

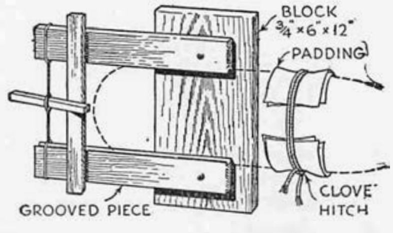
Any basement, boathouse, or camp will have the essentials for making a good job—light cord, a few nails, a knife and hatchet, and some sort of waterproof glue. The repair of a paddle will be described, but the same method is, of course, applicable to thin panels or any similar type of work.

Pad the edges of the blade and place a clove hitch just beyond the end of the split to prevent it from running further. Then mix your glue, if you use the casein variety, which is best for the job in hand. While the glue is setting, look about for some waste planking—one piece about ¾ by 6 by 12 in. and two ¼ to ½ in. thick by 2 by 12 in. Groove the inner edges of the thin pieces, making sure that these edges are straight.

Lay the blade lengthwise along a small round stick and press the edges downward to open the split while glue is rubbed in with a circular motion of the forefinger, first from one side and then from the other. Wipe off all excess glue. Lay the paddle blade on the heavier piece of scrap wood and press the grooved edges of the other pieces against the edge of the blade, allowing 2 or 3 in. to project, as shown. Nail the inner ends to the heavy cross member with one nail each. Now take a few turns of light line around the projecting ends of the grooved pieces, draw taut, insert a short piece of stick, and twist until the glue squeezes from the split, indicating a tight joint. To hold the tension without forcing the blade out of shape, lay a stiff stick across the grooved sidepieces for the tension bar to rest against.

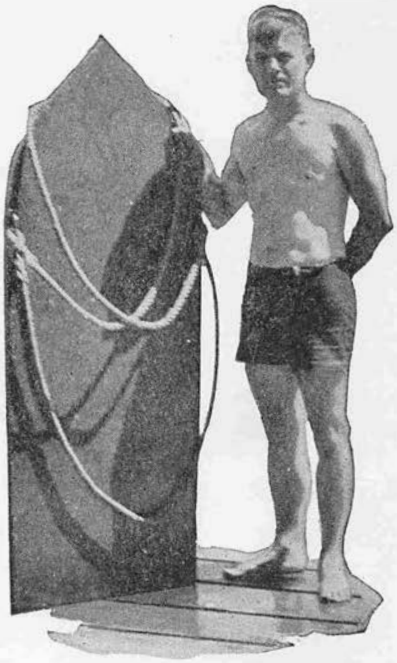
Wipe off excess glue and allow to set for a while. Then wipe on another coat of glue to fill any small edges of the crack and again wipe away excess.

The joint will be dry in twenty-four hours, or sooner with some of the fast-drying glues, but for a really good job it should stay in the clamps for a week. Then the crack is sanded lightly with fine sandpaper, shellac is rubbed on, and the whole blade is sanded and varnished.



How the clamp is made. Twisting the cord tightens the grooved pieces against the work

A hollow board of this type is lighter and stronger than a solid aquaplane of equal proportions. It is stable in the water, yet well adapted for doing stunts



BUOYANT
Hollow Aquaplane
COSTS LITTLE TO BUILD

FEW thrills compare with a ride on an aquaplane behind a fast runabout. Of course, the aquaplane must be a good one, easy to manipulate, but stable. It must have the right hitch, the riding angle must be correct, and there must not be too great a drag for the power available. To meet these conditions at minimum expense for materials, a hollow board like that illustrated will be found satisfactory and at the same time comparatively easy to build. The materials cost less than $2.50.

The board has a natural buoyancy of about 60 lb., due to its hollow construction, and this greatly reduces the initial drag at starting. It consists of a frame, made of 1 by 2-in. strips of spruce, cedar, or white pine, shaped around cross ribs to a conventional boat shape. The frame strips are rabbeted on upper and lower inner edges to take a ¼-in. waterproof (that is, casein-glued) three-ply fir covering, top and bottom. The edge strips and rear rib are of uniform depth, 2 in. The three intermediate ribs are flat on top and flush with the lower surface of the rabbet in the frame. This results in a flat top or deck on the finished aquaplane. The lower surface of the intermediate ribs, however, is dropped to make the board deeper in the center, and deepest at a point 18 in. back from the nose.

As the drawings show, the aquaplane is 2 in. thick around the edges, but 2¾ in. thick at the center of the forward rib, 18 in. from the nose. The other two intermediate ribs are 2½ and 2¼ in. deep respectively. Since the board will leak to some extent, each of the ribs is notched so that the water may be drained from a corked hole in the rear rib.

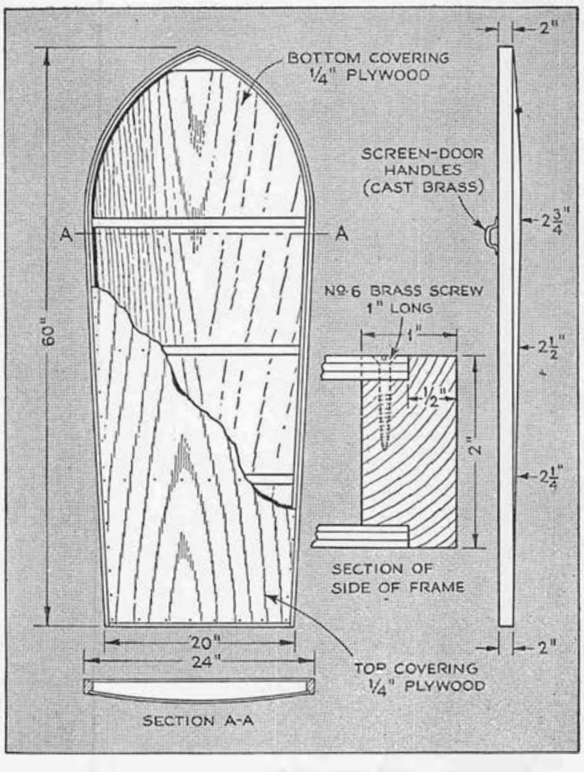
After the frame is assembled, the deck is fitted to the rabbet and set up in marine glue or white lead with 1-in. No. 6 brass screws, spaced 2½ in. apart. The board should then be clamped, top down, to a flat surface to prevent warping or twist while the bottom is applied over the curved ribs. The inner surfaces of the entire board should be primed with white lead just prior to assembly to prevent absorption of water. After assembly the entire board may be given a natural finish with spar varnish, or primed with white lead and finished with colored lacquer, the edges being painted a contrasting color.

Two cast-brass screen-door handles are fastened to the upper edge, at the ends of forward rib, for a ½- or ¾-in. hemp rope pull-off bridle, to which the tow rope is attached. A ¾-in. hemp rope hand-hold bridle of suitable length is also spliced to the handles.

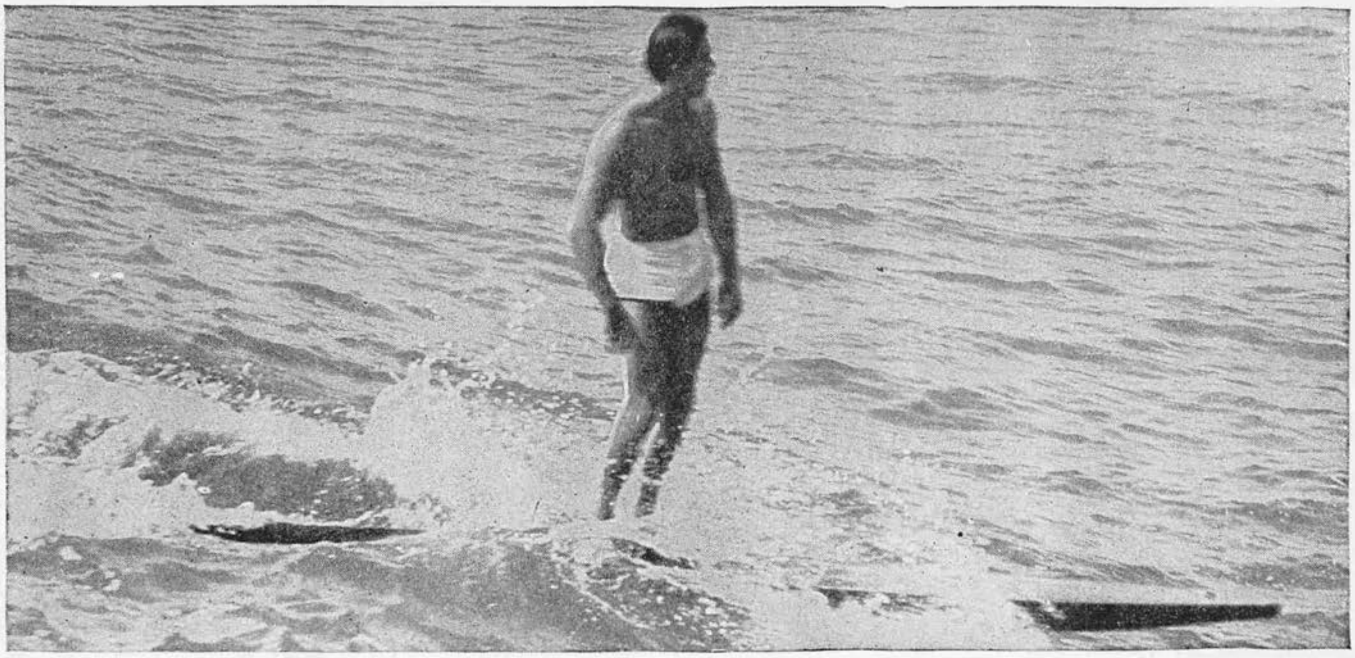
The best planing angle is as flat to the surface of the water as can be maintained without cutting into the waves. A standing position about 18 in. forward from the tail, between the two rear intermediate ribs, seems to be correct. By inclining the board to right or left, it may be skidded completely across the wake of the towing vessel; by inclining acutely—"kicking" the board—and pulling up on the bridle sharply, the board can be jumped clear out of the water.

This board has been used successfully behind a 16-h.p. twin outboard motor with a 14-ft. boat at 16 or 18 m.p.h., and has also shown its stability and its responsiveness to control when being towed in the wake of a homemade 16-ft. sport boat. The latter is powered by a 32-h.p. inboard motor with a 12 by 18 wheel, and pulls the board at better than 20 m.p.h.

Because of its shape, the board has a natural rise at the start and a greater degree of flexibility in the water, especially for stunts, than a solid board of equal proportions.



Top and edge views of the hollow aquaplane, a cross section, and an enlarged detail showing how the sidepieces are rabbeted



BETTER WAYS TO BUILD Surf Boards

AT THE California beaches there are schoolboys who easily rival the best Hawaiian experts in the thrilling sport of surf-board riding. That is partly because of the superior surf boards they use—light, buoyant, and beautifully finished.

With the aid of the accompanying drawings, any amateur woodworker can build equally good surf boards. These designs are of the type used at the Newport Harbor (Calif.) Union High School, where construction of surf boards is a specialty. Two of the plans are for large boards, which may be paddled far from shore and used in deep water; a third design is for a smaller and simpler board of the toboggan type; and the fourth is a child's paddle board.

The balsa-wood surf board shown in Fig. 1 is so light that it can be carried about easily, and it has exceptional buoyancy in the water. Since balsa has no great strength in itself, the board is reënforced

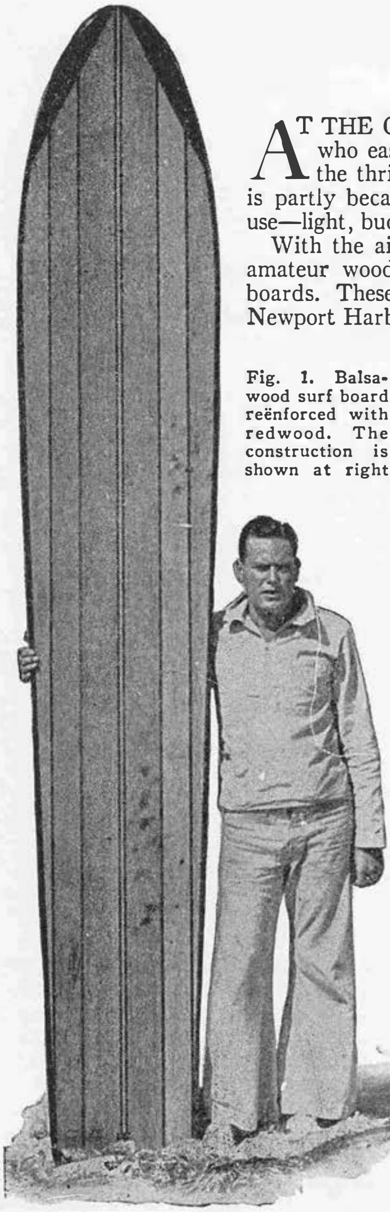
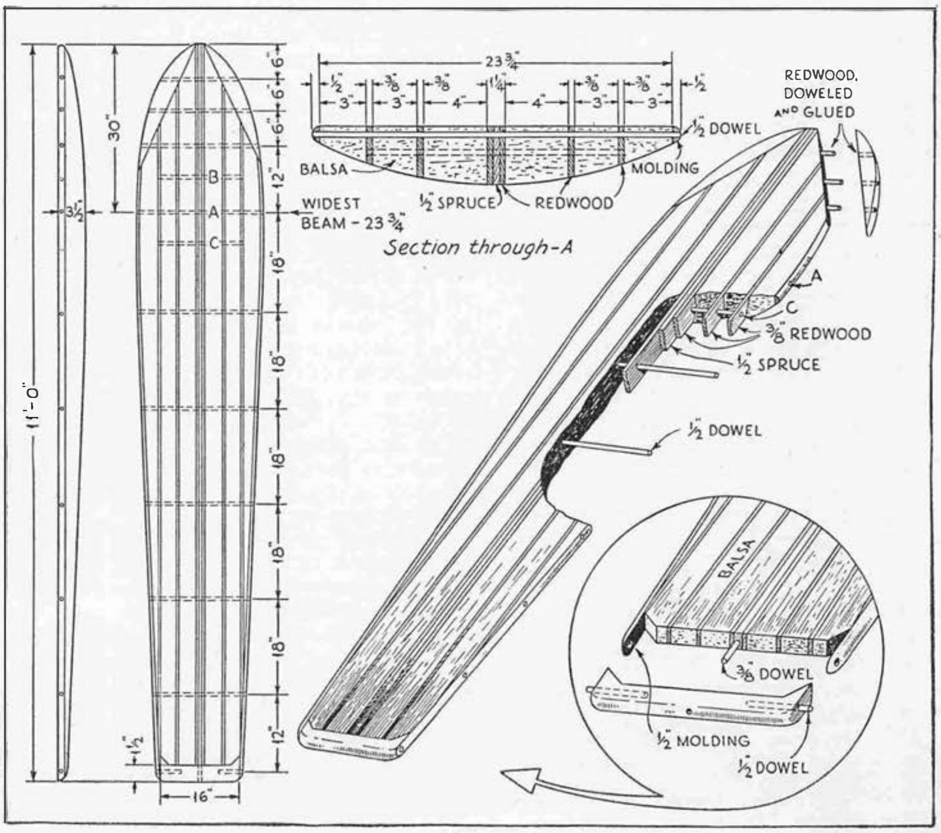


Fig. 1. Balsa-wood surf board reënforced with redwood. The construction is shown at right



A reënforced balsa-wood design—Laminated pine-and-redwood construction—Curved-head or toboggan types—Boards for children

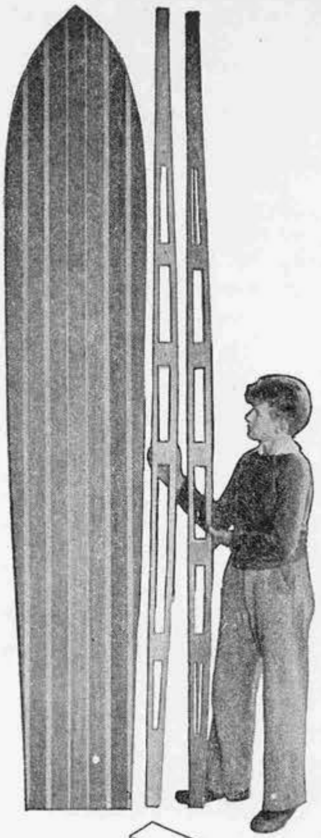
with redwood longerons and a central backbone of spruce sandwiched between two pieces of redwood. There are no nails or screws, the sections being securely held together by dowels and casein glue.

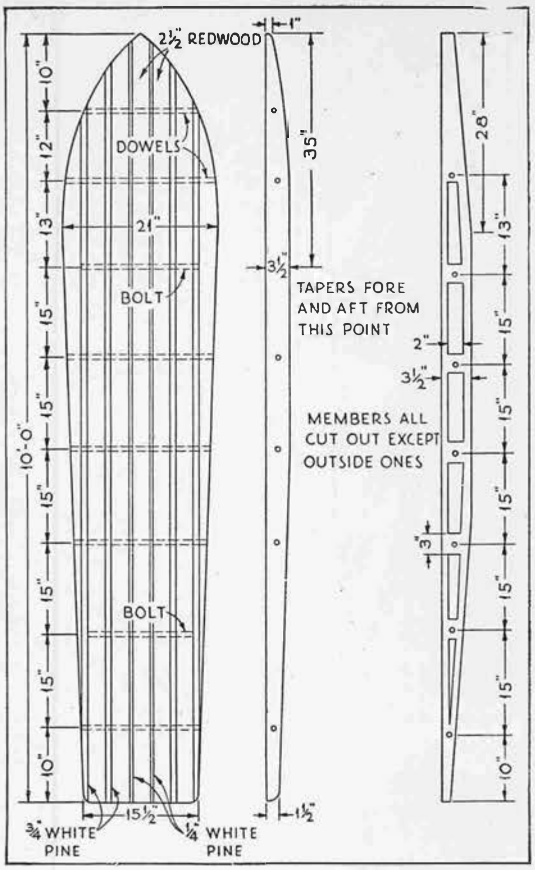
The first step is to make the backbone. It is a ½ by 3½ in. strip of spruce glued between two ⅜-in. redwood strips of the same width. On each side of the backbone, glue balsa timbers, 3½ by 4 in. by 10 ft. 11 in. Continue to add strips of redwood and timbers of balsa, as indicated in the cross-section drawing. Two dowels, marked *B* and *C,* should be inserted before the two outer pieces of balsa are put on. Their centers are located 1½ in. from the top. When the assembly is completed, shape the built-up plank by cutting the outline as illustrated in the plan drawing. Allow about ¼ in. all around for trimming to exact size. Before doing the trimming, however, plane the bottom to a taper, fore and aft, from the widest beam, which is 30 in. from the nose.

After the board has been planed and sandpapered, glue the curved sections on the nose, and add the stern piece, which should be of redwood. When the glue has set, bore holes for the dowels and insert them. Note that the centers of all except the two previously mentioned are located about ¾ in. from the top.

The ½-in. half-round molding should be neatly fitted, and the finish will be greatly improved if redwood plugs are set in over the ends of the dowels.

If waterproof casein glue has been used liberally in all joints so that water will not seep into the porous balsa, give the entire board four or five coats each sandpapered, of high-grade





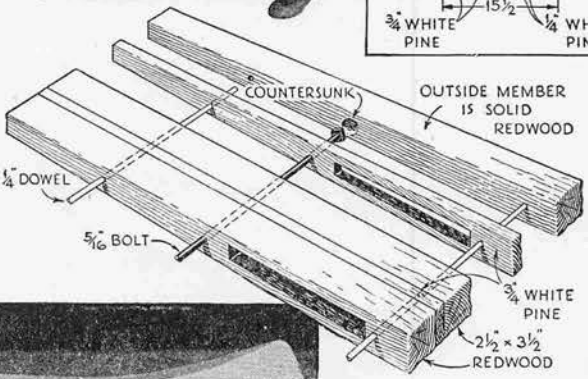


Fig. 2. How to make a laminated surf board of redwood and white pine. To reduce the weight, all the strips except those on the outside are cut away as shown. A finished board appears in the photo at left above, together with two sections. The method of assembly is indicated at the left

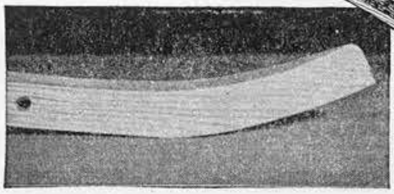


Fig. 3. The forward end of one section of a toboggan-type board. All the drawings are given below

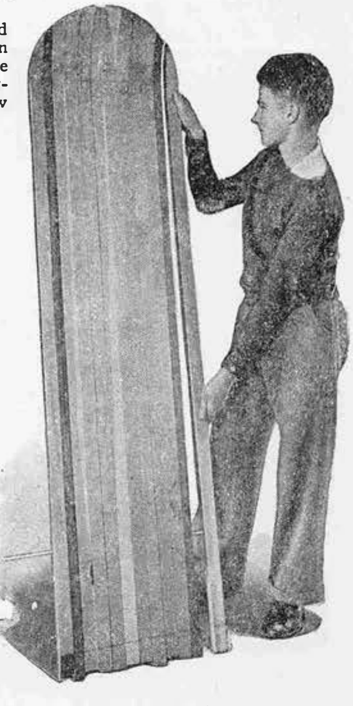
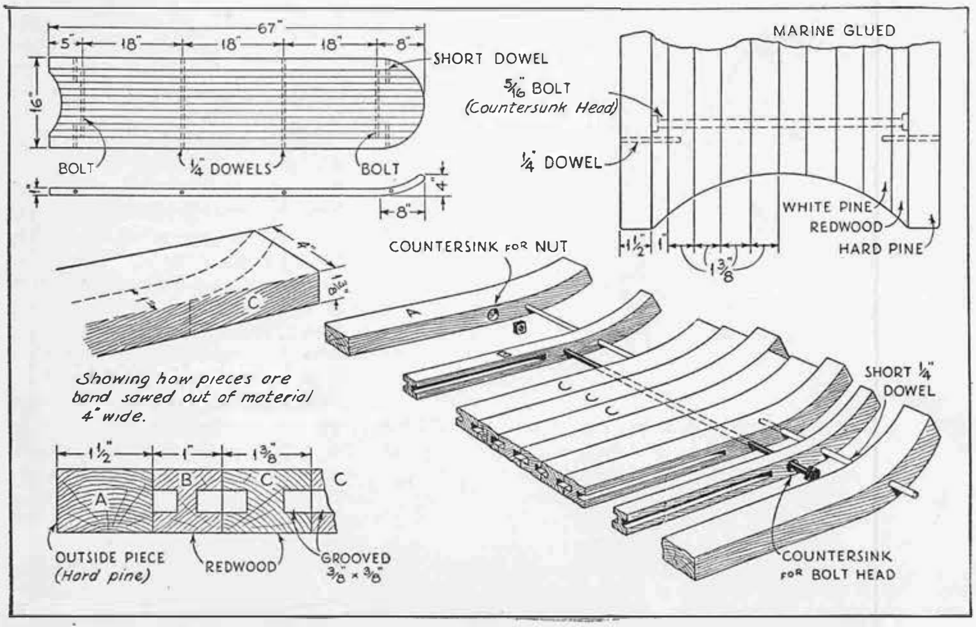


Fig. 4, A student of the Newport Harbor (Calif.) Union High School with a partially completed toboggan surf board, made as shown at the left



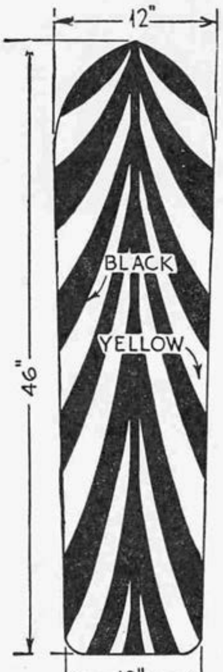


Fig. 5. A child's board for paddling

spar varnish, rubbing well with steel wool after each one except the last.

Bear in mind that this type of board is not expected to take punishment on rocky shores or on gravel, because the balsa is easily dented.

The laminated red-wood-and-pine board shown in Fig. 2 is similar in appearance, although it differs somewhat in construction, having air cells cut in the solid wood. It is put together with ¼-in. dowels and two 5/16-in. bolts with countersunk heads and nuts, as illustrated. Casein glue is used between the joints. Care must be taken when planing the assembled unit that you do not cut through into the air cells. This board should be varnished in the natural wood. Apply about four coats, and rub the first three, when dry, with steel wool.

The curved-head or toboggan type of board is illustrated in Figs. 3 and 4. This is adapted to ordinary surf in shallow waters, but is not intended to be paddled far from shore, as may be safely done with the others. It is a favorite with concessionaires at public beaches. As will be noted in the drawings, the fore ends of the pieces, one of which is shown in Fig. 3, are not bent, but are cut from straight stock. As the two outer pieces are 1½ in. wide, they obviously must be band-sawed from stock that thick, and 4 in. wide. All of the ten inner pieces are grooved, as shown, to reduce the weight. Dowels, casein glue, and two bolts are used in the assembly. This type of board also looks best if finished in the natural wood with spar varnish.

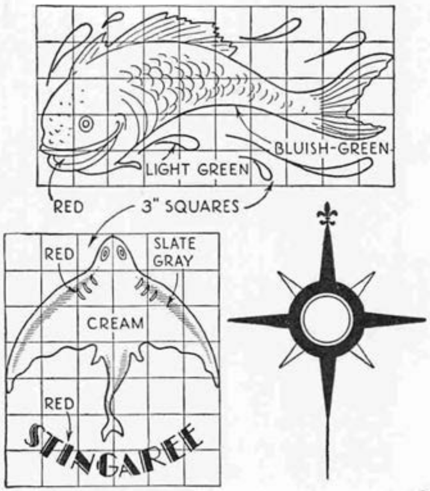


Fig. 6. Designs for decorating surf boards

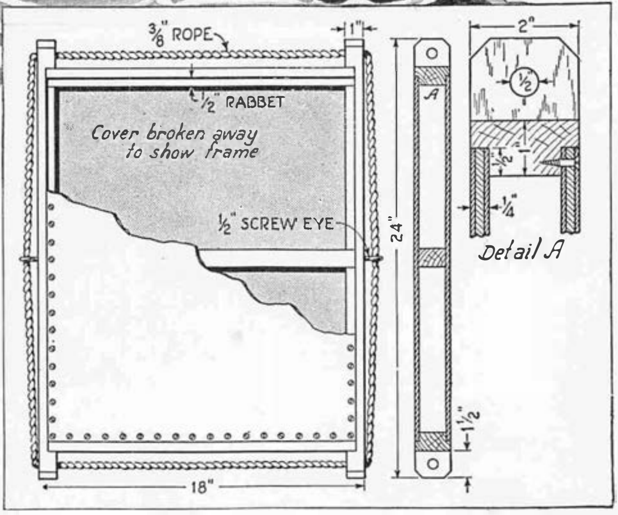
The child's paddle board, Fig. 5, is made from a single piece of white pine or redwood. It should be ¾ or 1 in. thick. Two or three ⅜-in. dowels or ¼-in. brass rods will lessen the dange of splitting. This type of board lends itself to striking decorations, and it is a good idea to paint an unusual pattern with bright colors, as suggested in Fig. 6.

STRIPS FROM OLD INNER TUBES USED IN PLACE OF CLAMPS

A GOOD emergency clamp, especially for irregularly shaped work, can be made by cutting a long strip of rubber from an old inner tube and wrapping it around the pieces to be held. If the rubber is stretched hard and one winding is put over another, great pressure can be obtained. One application of this idea is in making archery tackle. Rubber bands about 1 in. wide are used to bind on extra stock for bow handles while the glue is setting and also to bind the steamed ends of reflexed bows to the form which holds them in shape until the wood dries.

Hollow Swimming Board Helps Beginners

The board may be used as a "base" for swimmers in deep water or to give confidence to beginners. It is of especial help in learning to kick properly



TO THE average boy or girl, half the summer's fun, whether at the beach, the lake, or just "the old swimmin' hole," is associated with the water. One accessory that will add to the fun and be of practical use to the novice is a swimming board, like that illustrated. A learner may use the board for support while practising the thrash kick. Another use is as a temporary rest or "base" for a group swimming in deep water, or to give greater confidence to a beginner by demonstrating his buoyancy in the water.

The board is 18 in. wide, 24 in. long, and 2 in. thick, less projections, and displaces approximately ½ cu. ft. water. Neglecting for the moment the weight of materials, the board thus has a buoyancy of approximately 30 lb., as required for life preservers of the approved type.

The frame is of 1 by 2-in. white pine, spruce, or cedar, rabbetted on the top and bottom inner edges to receive a covering of ¼-in. 3-ply fir of the water-resisting type—that is, glued with waterproof glue. The side rails project 1½ in. beyond the ends in order to pass a rope through ½-in. holes. Galvanized or brass screw eyes may be used midway of the side rails to secure the rope in the form of several convenient loops. The end rails are mortised into the side rails to the depth of the rabbet.

After the frame is assembled and painted, the top and bottom 3-ply covering boards are cut to fit the rabbet and set in marine glue or white lead with 1-in. No. 6 screws, spaced 2 or 2½ in. apart. Before assembly, the inner sides and edges of the plywood should be primed with spar varnish or white lead to render them more waterproof.

The completed board may be finished with natural spar varnish, or with white lead primer and white or colored enamel or lacquer. The edges and rails are painted a contrasting color.

After the paint is fully dried, a length of ⅜-in. Manila rope is loosely threaded through the holes in the side rail projections, and the free ends are spliced with three passes.

The original swimming board from which these plans were drawn has been in use for more than four years, and during that time it has served to teach three young children to swim in over 30 ft. of water by the time they reached an age of from 4 to 6 years. It has also been used to teach two 16-year-old non-swimmers tackle the same deep water, making them confident swimmers in about two weeks' time.

Besides its usefulness in teaching young or old people to swim, the board has been the source of endless enjoyment.

Boy's Boat

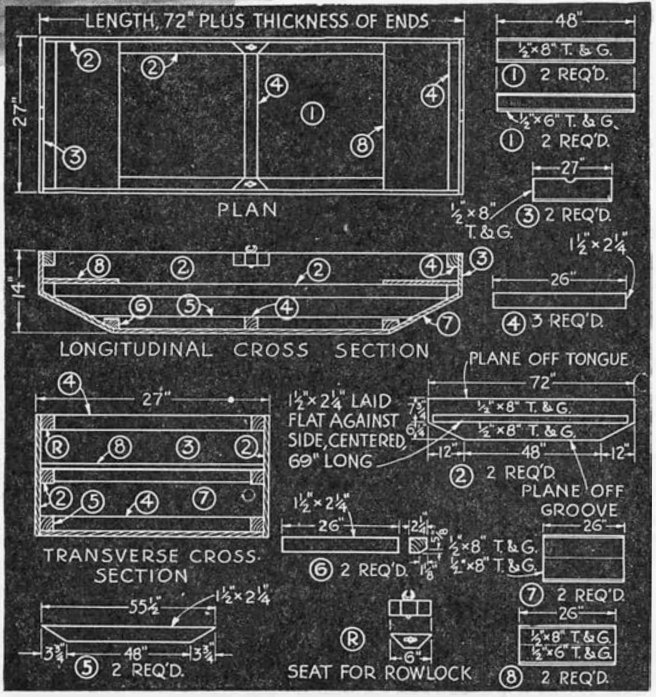
BUILT FOR

Five Dollars

Although it weighs only a trifle more than 66 lb., this little punt will support 500 lb. in the water

YOU can make life more enjoyable for your boy this summer, if you happen to live near a bay, lake, or other waterside, by letting him build a small lake punt similar to those used on the Serpentine in London, England, or on the English lakes.

The punt illustrated was built largely by a 13-year-old boy. It will support 500 lb. in the water, yet children can carry it, turn it over when necessary, and launch it unaided. It may even be used as a platform from which to dive. The oars, too, are homemade, although these can be purchased very cheaply at any dealer in boating supplies. The same applies to oarlocks; one can buy the commercial product, or make simple tholepins.

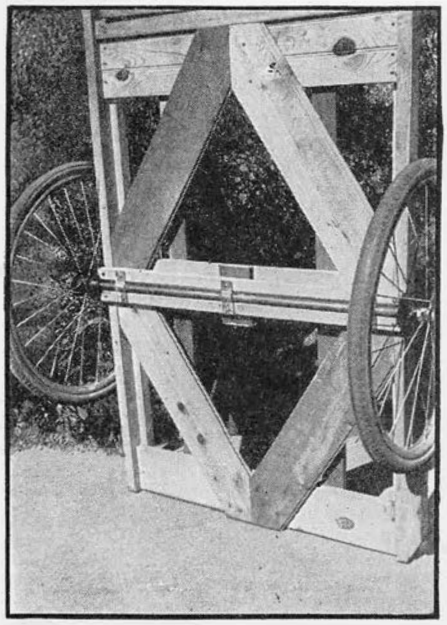


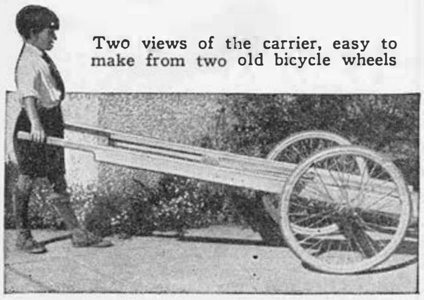
The punt weighs a fraction more than 66 lb. The cost of lumber was $2.80, hardware and putty $1, and paint $1.20, although prices will vary to some extent according to the locality and the grade of materials selected. The construction required 24 hours.

The drawings are self-explanatory, but a few hints may be helpful. White pine lumber may be used throughout because it is so easy to work and can be obtained already tongued and grooved. The parts are nailed together except in a few vulnerable points at the corners and where two sides meet at an angle.

Seam composition or putty of a type sold for hull construction should be applied liberally. In the absence of a prepared composition, mix two parts of paste white lead and one part of whiting. Apply the putty in the grooves and on the tongues and in all seams, and squeeze the surplus out by using carpenter's clamps. Scrape off the surplus putty for use elsewhere. Set the heads of the nails 1/8 in. into the wood and fill the holes with putty.

Give the punt three coats of good quality paint, preferably of a grade sold for use on boats. The coats should be applied about a week apart.





Two views of the carrier, easy to make from two old bicycle wheels

If you live some distance from the shore, a carrier can be made as shown in the photographs. Its frame is supported on two old rear wheels obtained for 50 cents each at a bicycle shop. Check up on the spokes and tires. Remove the inside of the hubs, but leave the washers, ball bearings, and caps; then mount the wheels on a suitable wooden frame by means of 5/8-in. gas pipe. Slide the punt on the carrier until it is in balance. The carrier will carry safely about 200 lb. It is surprising how little effort is required to move the punt in this way. A 10-year-old boy can wheel it without undue strain.

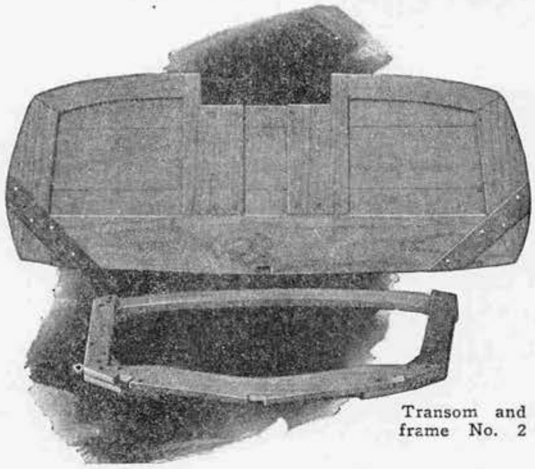
SPEED AND COMFORT COMBINED IN THIS

Racing Runabout

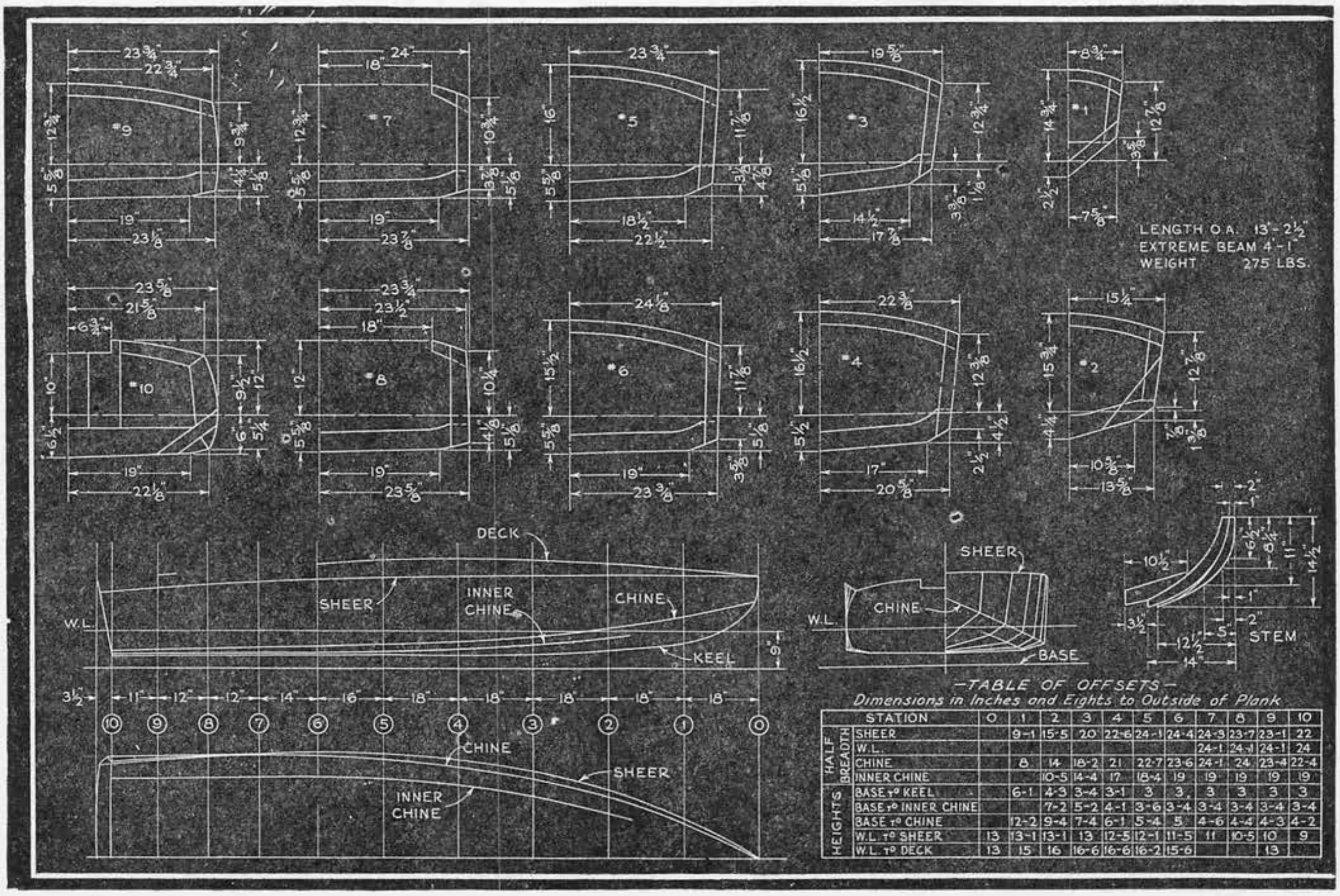
THIS new 13-ft. racing runabout answers the demand for a boat that can be raced successfully, yet has features of size, stability, riding comfort, and seaworthiness that make it ideal for general pleasure use. It meets all requirements of the runabout racing class, the rules of which prevent the entry of out-and-out racing boats.

The building of racing runabouts was pioneered several years ago on the Pacific Coast, and the new boat is the result of much experience in designing, racing, and manufacturing them. Several previous designs have set world's records for runabout classes. The final result of countless refinements and changes, this new racing runabout will hold its own in the stiffest competition to be found anywhere in the country, yet it will carry a load well and ride smoothly. Beveled chines make the craft nontripping, regardless of how sharp a curve is attempted. Simplicity of construction has been stressed; for instance, no rabbeting is necessary except in the stem.

The over-all length of the craft, measured according to the racing rules, is just over 13 ft., which is the minimum length. The water-



Transom and frame No. 2



—TABLE OF OFFSETS—

Dimensions in Inches and Eights to Outside of Plank

	STATION	0	1	2	3	4	5	6	7	8	9	10
HALF BREADTH	SHEER		9-1	15-5	20	22-6	24-1	24-4	24-3	23-7	23-1	22
	W.L.								24-1	24-1	24-1	24
	CHINE		8	14	18-2	21	22-7	23-6	24-1	24	23-4	22-4
	INNER CHINE			10-5	14-4	17	18-4	19	19	19	19	19
HEIGHTS	BASE TO KEEL		6-1	4-3	3-4	3-1	3	3	3	3	3	3
	BASE TO INNER CHINE			7-2	5-2	4-1	3-6	3-4	3-4	3-4	3-4	3-4
	BASE TO CHINE		12-2	9-4	7-4	6-1	5-4	5	4-6	4-4	4-3	4-2
	W.L. TO SHEER	13	13-1	13-1	13	12-5	12-1	11-5	11	10-5	10	9
	W.L. TO DECK	13	15	16	16-6	16-6	16-2	15-6			13	

The lines of the racing runabout with a table of offsets giving the dimensions at the eleven station points, and detail drawings of frames and stem

A fast stepless hydroplane built to meet the National Outboard Racing Commission rules

No more striking proof of the efficiency of this boat can be given than the fact that it planes perfectly when only a nine-horsepower outboard motor is used. It is eligible for all runabout racing classes

line beam is 4 ft. ¼ in., or ¼ in. greater than the minimum beam allowed. It is eligible for all runabout racing classes—service motor classes C and E, and racing motor classes C and F.

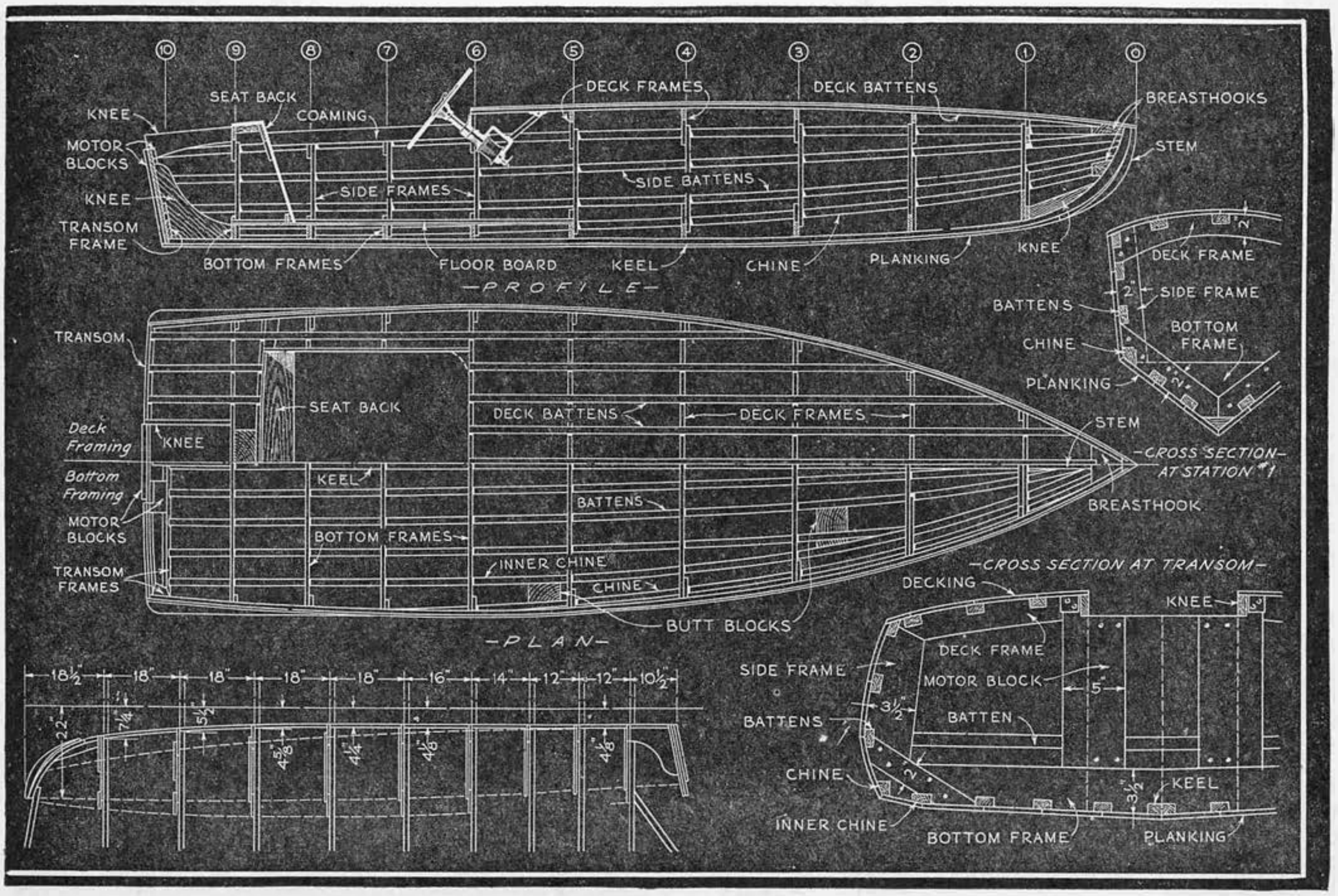
The National Outboard Racing Commission has specified various other restrictions in order to make sure strictly racing boats cannot compete. Some of these restrictions are: minimum hull weight for classes E and F, 275 lb., and for class C, 200 lb.; minimum total racing weight (crew, motor, boat, etc.) 775 lb. for classes E and F, and 550 lb. for class C; no step in the bottom of the hull; minimum freeboard 15 in.

The ideal materials to use are: Philippine mahogany for planking (other types of mahogany are usually much more expensive), and airplane spruce for the entire framework. The total cost, including all hardware and fittings, should not be over $50, but it will vary a great deal in different parts of the country. If mahogany or spruce cannot be obtained locally, the best second choice would be cedar for planking, battens, and chines, and oak for frames and keel. In the list of materials on a following page the other materials are listed in order of their suitability.

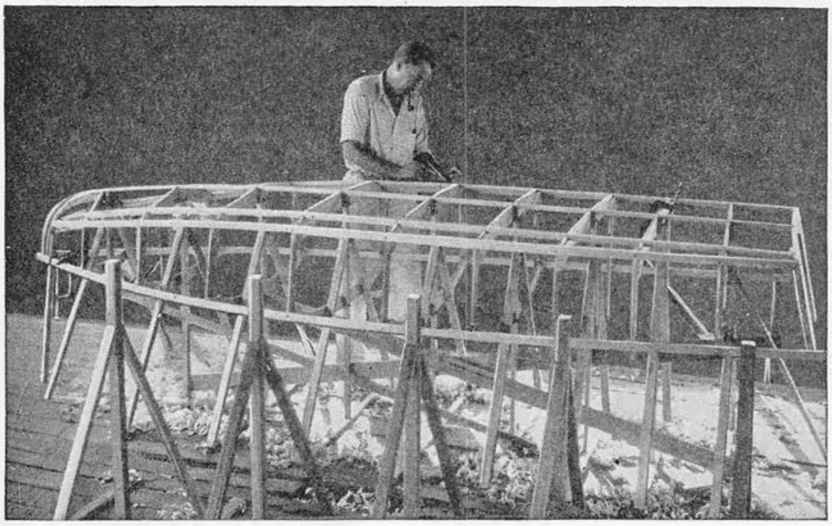
All screws and bolts should be flathead brass unless otherwise specified, but if the boat is to be used only in fresh water, galvanized iron can be substituted to reduce the cost.

If mahogany planking and spruce framework are used, the boat will weigh very close to 275 lb., including all fittings. All of the alternate materials listed for the framework are heavier than spruce, but some of the other materials specified for planking, such as cedar and spruce, are lighter than mahogany. As the racing rules call for a boat weighing 275 lb. for classes E and F and only 200 lb. for class C, a set of specifications are given at the end of the list of materials for the light class-C boat.

The first thing to do is to draw a complete set of full-sized patterns on heavy



Two views of assembled framework, a cross section at station No. 1 and another at the transom, and a diagram to aid in setting up the frames



Chines, inner chines, keel, transom, and stem must be faired and beveled to receive planking

paper such as wrapping paper. Take a sheet of wrapping paper the right size for one of the assembled frames and fold it in the middle. This fold will represent the center line. Next draw the water line at right angles to the fold. Then draw in the side and bottom frames according to the measurements given in the drawings. When this is done, punch holes through the paper at the proper points, unfold, and draw the other half.

THE patterns for the deck frames will have to be drawn with the aid of a compass, which is made by tying a long string to a pencil.

To lay out the frames from the patterns, place each pattern over the frame material and punch through with a marking wheel. The frames can then be sawn out and planed to shape. While the center and side frames are being fastened together, place them over the patterns; this will offer a final check. All bottom frames except No. 1 can be made in one piece, but corner pieces will be necessary at frame No. 2, as shown in the drawings. Bottom frame No. 1 and all side frames except Nos. 8, 9, and 10 can be cut from a straight 2-in. board. The notches for the keel may be cut in each frame at this time.

Fasten the frames together at each corner with two bolts, such as 1½-in. No. 10 machine screws, or with copper rivets. The bolts or rivets will have to be set in somewhat in the forward frame to allow for beveling. The transom frames and motor blocks should be cut out as shown in the drawings and screwed to the transom with 1-in. No. 8 screws. Coat the surfaces that are to be joined together with marine glue before fastening.

It will be necessary to draw a pattern for the stem, taking the measurements from the drawings. The stem should be cut from a piece of 1¼-in. oak and shaped as shown. Cut the rabbet to the correct depth for the thickness of the planking that will be used. Fasen the stem knee to the stem with several long screws.

Next set up the supports to which the frames will be fastened while the boat is being built. This framework is shown in the photographs, and the necessary measurements are given in one of the drawings. The essential part consists of an upright at each station to which the frame will be fastened. These uprights, of course, should be set up in perfect alignment, absolutely plumb. Brace them well at each side.

Mark the location of the base line on the uprights with some kind of straightedge, and measure down from the base line for the location of the stem and inner keel line. Then, in order to get a true keel line, clamp a light batten over the uprights. Cut off the uprights at the inside keel line. Draw a line down the center of each upright, and mark the exact center line of each bottom and deck frame.

Now the frames can be clamped or bolted into the correct position. The center line of each bottom and deck frame should correspond to the center line on the upright, and the keel notch should be flush with the top of the upright. The keel can next be set in place and screwed to each frame and to the stem knee with 2-in. No. 10 screws. After the keel is beveled forward, the stem can be fastened in position.

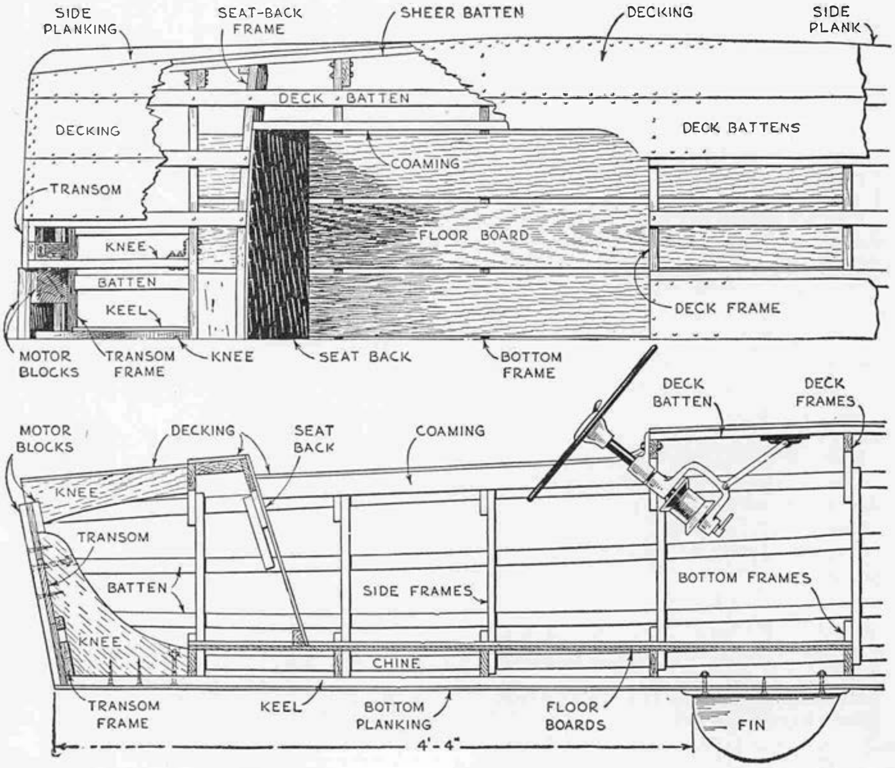
The transom should be secured to the keel with a large knee as shown in the drawings. Fasten the transom to the knee with several 2-in. No. 10 screws and at least one ¼-in. bolt; follow the same procedure in fastening the keel to the knee.

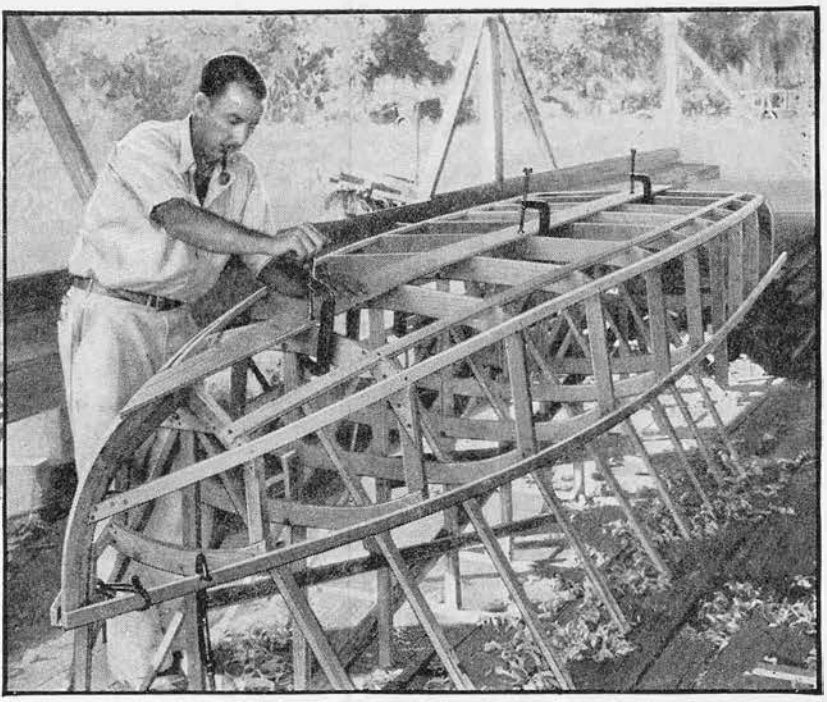
The notches may now be cut for the chine and inner chine pieces. Before cutting the notches for the chine, clamp a light batten in place to make sure of getting a true curve and the proper bevels. It will be easiest to run the inner chine only as far as frame No. 1. The seam from this point to the stem may be made water-tight by putting in a small batten after the boat is turned right side up. Cut the chine pieces down to a thickness of about ¼-in. at the points at which they are notched into the stem; deeper notches would weaken the stem. The same applies to such battens as are notched into the stem.

SCREW the chines to the stem with 1½-in. No. 8 screws and also to a breasthook fitted between the two chines at the stem, as shown. Bend back both chines at the same time, in order to avoid pulling the stem out of line. Clamp them in place and see that they are in a true curve; then fasten them to the frames with 1½-in. No. 8 screws. Also be sure that all frames and the transom are at right angles to the keel. Do not cut any notches for chines or battens into the transom, but only into the transom frame.

Next bevel and fair the chines, inner chines, keel, transom, and stem so that the planking will fit perfectly. Befor laying the planking, cut a waterway on either side of the keel as shown in the drawings.

Battens can be put in as the planking is fitted. Three bottom battens are required on each side of the keel. They should be placed so that the planks will all be the same width at the transom. Forward, the battens should be placed essentially as shown in the drawings. The side batten next to the chine should run at the water line from the transom to frame No. 8. Take





Stern view of the new stepless hydroplane designed especially to meet national racing rules. Note arrangement of tiller lines. Right: Plank clamped in position for fitting

particular care in fairing up the upper side batten (the sheer line), as it will make a great deal of difference in the appearance of the completed boat. Fasten the battens to the stem, frames, and transom frame with 1¼-in. No. 7 screws. It will be best to check the entire framework again before starting the planking, to make sure it is perfectly true and fair. A light batten laid over the frames will show any unevenness.

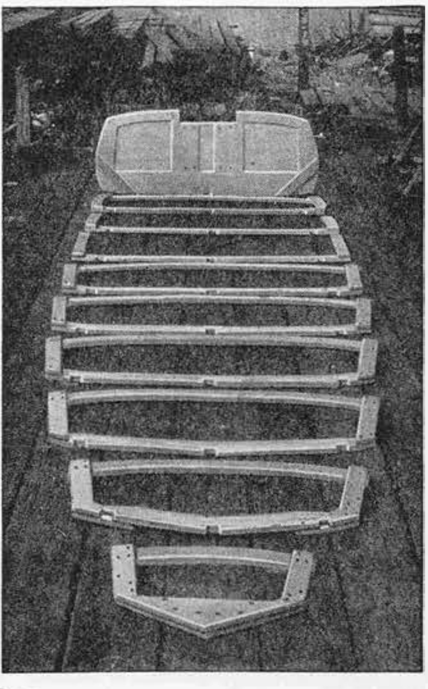
THERE will be five bottom planks on each side of the keel, all of which will require fitting. If the battens are spaced approximately as shown in the drawings, the first two planks on either side of the keel can be made from 6-in. boards, but 8-in. widths will be required for the rest of the planking. All the planks should be fitted so that the seams come exactly over the center of each batten. The various planks can be fitted by clamping them in the proper position and then marking them from the inside along the battens with a pencil. Then, with the aid of a light batten, mark out the shape of the plank, first adding to each side of the plank one half the width of a batten.

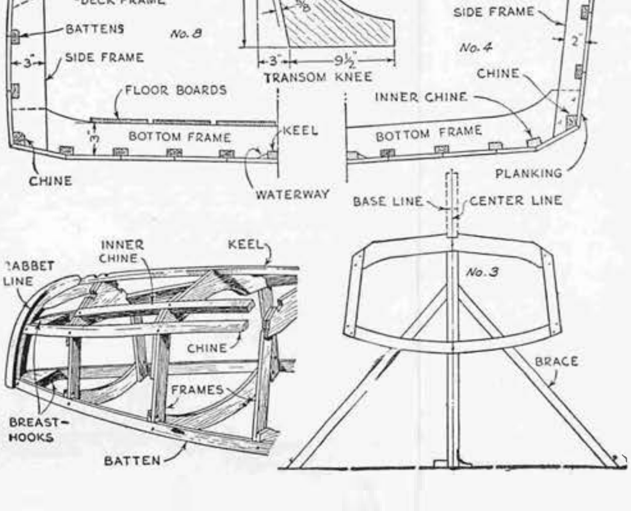
Another method of marking the planks is to chalk the center line of each batten before clamping the plank in place. Enough of the chalk will come off on the plank to show reasonably accurately what shape it should be. An ordinary pencil compass will also be of use in marking the planks for the final fitting. The planks below the water line should not be fitted together tight; the seams should be left open about 1/16 in. to allow for swelling.

The outside bottom plank will have to be made in two pieces, spliced as shown between stations 5 and 6. It will also be easiest to stop the third and fourth plank (counting out from the keel) between stations 2 and 3 and use one plank in their place from that point forward. Butt blocks of the same thickness as battens should be used at these joints.

Start by laying the first two planks on either side of the keel. Just before screwing down the planking, coat with marine glue the battens, transom, stem, keel, chines, and all joints that need to be waterproof; then lay a strip of cotton flannelet over the glued surface. Coat the cloth with glue. When the planking is screwed down, the glue will be squeezed over the entire joint, making it completely waterproof. Also, the cloth will hold the glue in place indefinitely. Small battens that cover the bottom transom seam should be made waterproof in this manner. No cloth or marine glue will be needed, of course, in any seams which are above the water line.

When a plank is being fastened, it should first be clamped in place; then holes are drilled in it for the screws. These screws should be countersunk enough to allow for covering later with putty or seam composition. Screw the side and bottom planking with flathead brass or galvanized screws as follows: (1) A double row into transom and transom frame, 1-in. No. 6, spaced about 1 in. apart; (2) into stem, 1-in. No. 6, spaced not over 1 in. apart; (3) into keel, chines, inner chines, and frames, 1-in. No. 6, spaced about 1½ in. apart; (4) into battens, ⅞-in. No. 6, spaced about 1½ in. apart.

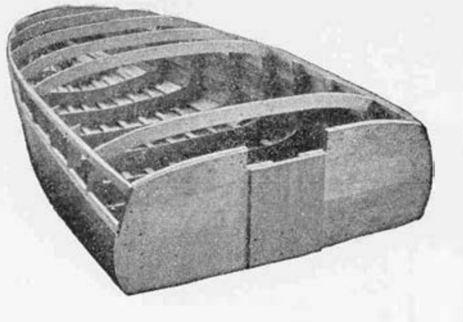




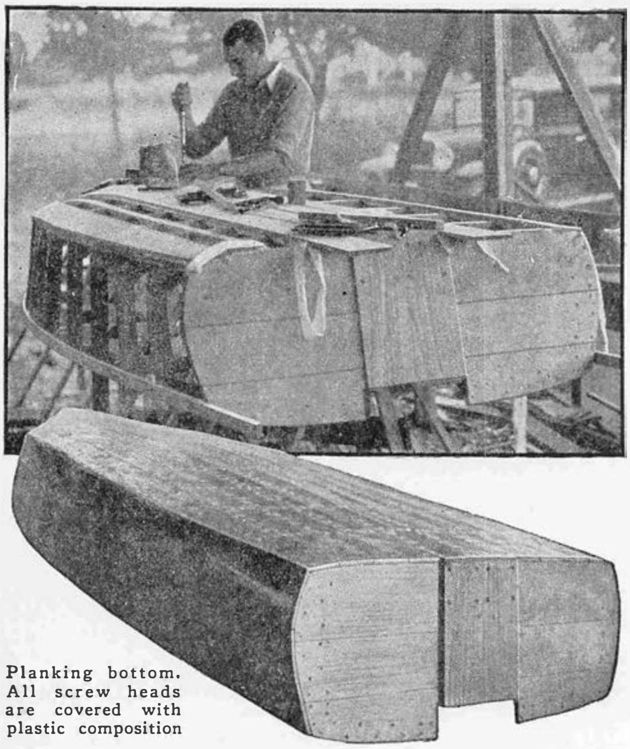
Transom and complete set of frames before being set up. *Left:* Additional drawings

Some planks will have to be steamed, especially the ends of planks near the stem and bottom side planks near the transom. To steam a plank, wrap with rags the part that is to be bent and then soak the rags with boiling water. Once the rags are taken off, the planks must be quickly clamped and screwed into position before they dry.

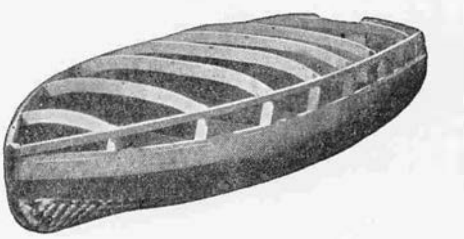
Before the top side plank is put on, the boat can be removed from the supporting framework and set, right side up, on



Stern view of the partially completed boat after being turned right side up. Left-over pieces of planking are used for the flooring



Planking bottom. All screw heads are covered with plastic composition



A bow view. The deck beams should be trued up to give a smooth, fair curve fore and aft

horses. Fit the breasthook against the stem between the two top battens before the last two side planks are put on. Screw through the battens with 1¼-in. No. 7 screws.

After the side planking is completed, true up the deck beams, bevel the battens and planking along the sheer line, and bevel the top of the transom and transom frame, so that the decking will fit properly. Be careful to get a true curve of the deck fore and aft, especially at the sheer line and center line. The small deck frames Nos. 7 and 8 and also the coaming can be put in at this time.

The deck frame to which the back rest is to be fastened can be set up at any desired angle. It should be fastened at each side to small cleats attached to the two top battens; and at the center it should be connected with a block to deck frame No. 9, as shown in the drawings, with 1¼-in. No. 7 screws. Screw the coaming to this seat-back frame and to deck frame No. 6 with 1¼-in. No. 7 screws, but ⅞-in. No. 6 screws will be large enough for the rest of the construction just described.

NEXT, the two knees that brace the transom to deck frame No. 9 should be fitted. Fasten them with small angle irons and bolt with 1½-in. No. 10 machine screws. Notches can now be cut for the deck battens. They should be spaced about 5½ in. apart, approximately as shown in the drawings, and fastened to the sheer batten and to the frames with 1¼-in. No. 7 screws. The center batten will be notched part way into the breasthook. Screw the deck to the battens, deck frames, breasthook, transom, transom frame, and sheer batten with ⅞-in. No. 6 screws spaced about 2 in. apart. No marine glue or cotton flannelet is necessary, but the entire inside of the boat should be given a coat of paint at some time before the decking is laid, and all the decking should be painted underneath beforehand.

It will be best to put in, before all the decking is on, proper bracing for the type of steering wheel to be used. The flooring can be made from extra boards left over from the planking. The seat back is plywood.

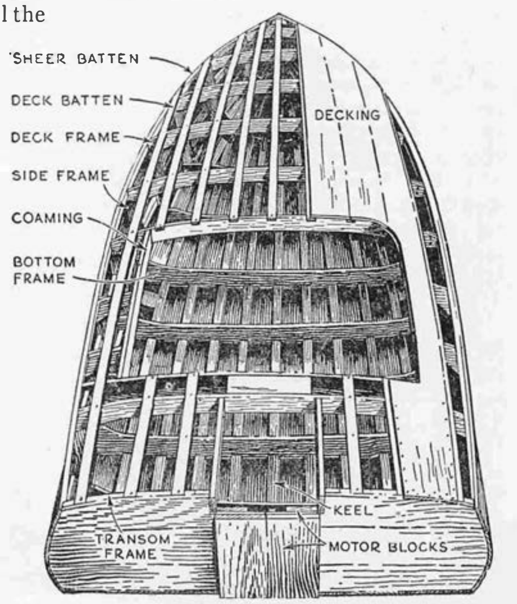
The entire hull should be well sanded before the priming coat is put on. All screws should be covered with putty, seam composition, or a plastic wood composition. The entire hull should have at least two coats of marine enamel or spar varnish.

TO OBTAIN a natural mahogany finish, first color the hull with either mahogany filler or mahogany stain. Apply either of these with a brush and then wipe off with old rags. Cover screw heads with mahogany colored seam composition. For an extra good racing bottom, use at least three coats of special hard, racing bottom finish; get instructions for applying from the paint manufacturer.

To mark the water line, first set the boat up evenly on a level floor; then mark all the way around the hull 6 in. up from the floor. The sheer molding and fender molding can be either half-round hardwood or ⅜-in. half-oval brass, screwed to the battens with oval-head brass screws. A strip of ⅜- or ¼-in. half-oval brass should also be used to protect the stem. A bow plate or some fitting to which a tow rope can be attached is required by the racing rules.

The best and simplest way to hook up the steering outfit is to use four pulleys, and to run the tiller line or cable to the steering bar through holes bored high in the transom.

In order to get great speed, have the transom as high as the motor being used will allow. You will probably have to experiment with this part to get best results. The motor angle also is important, and it is well to test the efficiency of the motor when it is tilted to different positions.



HANDY ROPE FOR MOTOR BOAT

A GENERAL utility rope for the runabout or small cruiser can be made by splicing a snap hook to each end of a rope 25 ft. long or longer. The boatman who likes to keep his decks clear of rope will find it useful as a bow line or stern line. One end can be slipped quickly to a ring on deck, while the hook on the other end acts as a weight and makes it easier to throw the line to a person on the shore or wharf; at the same time, it provides that person with an easy method of fastening the rope without resorting to an unreliable landlubber's knot. When not in use, the rope may be kept within easy reach of the steering position so as to be ready for immediate use. The snap hooks should be made of brass or galvanized iron, if possible; otherwise they should be well painted. Permanent bow and stern lines also can be improved by splicing snap hooks to their outer ends.

List of Materials

Materials listed in order of preference

For	No. of Pieces	Size	Material
Planking	12	⅜" x 8" x 14'	Philippine mahogany,
	4	⅜" x 6" x 14'	
Decking	10	5/16" x 6" x 10'	white or red cedar, spruce, cypress, or white pine
Transom	1	½" x 6" x 12'	Philippine mahogany, spruce, cedar, cypress, or white pine
Frames, transom frame,	6	⅝" x 6" x 12'	Spruce, mahogany, white oak (½" only), fir, maple, or yellow pine
motor blocks, coaming, deck beams knees, etc.	2	⅝" x 2" x 10'	
Keel	1	¾" x 2" x 12'	Spruce, mahogany, fir, or yellow pine
or	1	¾" x 1½" x 12'	White oak
Chines	2	⅞" x 1¼" x 14'	Spruce, mahogany, fir, yellow pine, or cedar
or	2	¾" x 1" x 14'	White oak
Inner chine	2	¾" x 1¼" x 12'	Spruce, mahogany cedar, fir, or yellow pine
Battens	12	⅝" x 1¼" x 14'	Spruce, mahogany, cedar, fir, or yellow pine
Deck battens	9	⅝" x 1¼" x 10'	
Stem, stem knee, transom knee, breast hooks	1	1¼" x 8" x 4'	White oak, hackmatack (tamarack), mahogany, or maple
Fender and sheer molding	5	⅝" half-round, 14' long	Maple, oak, or ash
or		40' of ⅜" or ½" half-oval	Aluminum or brass
Seat back	1	¼" x 1½' x 3'	Plywood

HARDWARE AND MISCELLANEOUS

Flathead brass or galvanized screws as follows: 17 gross ⅞" No. 6; 8 gross 1" No. 6; 2 gross 1¼" No. 7; ½ gross 1½" No. 8; and 2 doz. 2" No. 10.
1 gross 1½" No. 10 flathead brass or galvanized machine screws, and 1 gross No. 10 hexagon nuts
3 doz. 1" No. 6 oval-head brass screws
2—3" x ¼" flathead galvanized stove bolts
2 qt. marine glue (C quality)
4½ yd. cotton flannelet
1 qt. priming coat and 2 qt. marine enamel
1 outboard bow plate
1 outboard runabout-type steering wheel
20 ft. ¼" tiller cable
4—¼" tiller-rope pulleys
1 outboard fin, 6" x 12" or larger (aluminum)

CHANGES IN MATERIALS FOR 200-POUND CLASS-C RACER

Planking	5/16"	Philippine mahogany
Decking	¼"	Philippine mahogany
Transom, frames, transom frame, coaming, deck beams, etc.	½"	spruce
Keel	¾" x 1½"	spruce
Chines	¾" x 1¼"	spruce
Inner chines	⅝" x 1"	spruce
Battens	½" x 1"	spruce
Deck battens	½" x 1"	spruce

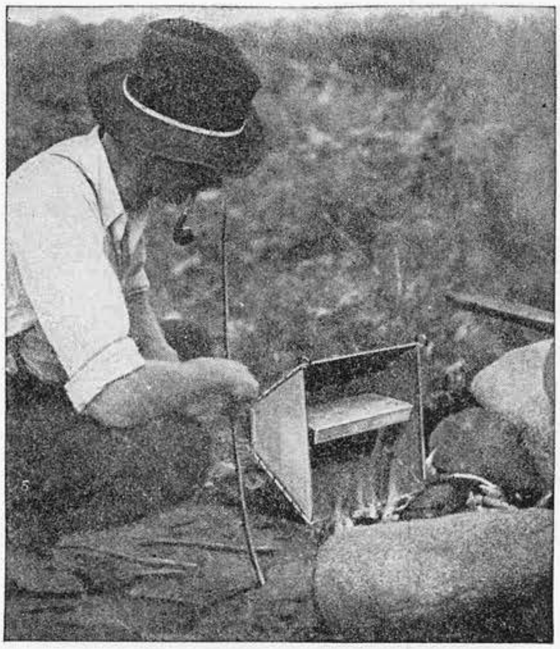
(Use ¾" No. 6 screws in place of ⅞" No. 6 for fastening into battens.

SCRAPS OF ELECTRIC CONDUIT MAKE USEFUL BRACES

SHORT sections of thin wall electric conduit make excellent braces, hangers, and supports. Beat the ends flat and drill for mounting holes. The flattened ends may be bent around conduits and drawn up tight with a bolt; the other end anchored to wall, ceiling, or another conduit. Short scrap pieces make excellent angle braces for shelving, platforms, and the like when mounted against a wall. The rigidity of tubing used in this manner is equal to, and often better than, strap iron; and because of its lightness and ease with which it can be drilled and bent, it can be installed much faster than strap iron.

Folding Reflector Baker

FOR MAKING HOT BISCUITS AND CAKES IN CAMP



With this baker, you can watch your cakes to avoid burning

BEFORE you start on your next camping trip, spend an hour or two in making this reflector baker. You will be well repaid for the effort in nicely browned, hot biscuits.

Materials. Flat, bright tin, 13 by 42 in.; 11 ft. of iron wire, ⅛ in. diameter (cut into six 12-in. pieces, two 9-in., one 30-in., and two 6-in., *not rolled*); ten ¼-in. iron rivets, and a baking pan about 1 by 7 by 11 in.

Tools. Scratch awl, tin snips, pliers, cold chisel, center punch, drill for rivets, file, and hammer.

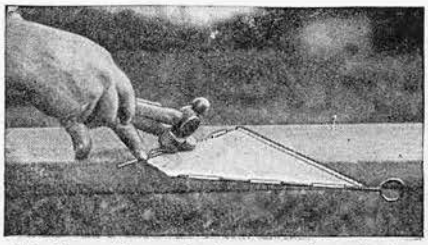
Construction. Lay out tin as in Fig. 1 and cut on all heavy lines. The two slots in the 4-in. piece are made with the cold chisel and should be only as wide as two thicknesses of the metal.

Turn and finish the edges that are to be permanently wired. Then bend the tabs along the edges that are to be hinged (Fig. 2). Match the edges, insert the wires, and test the hinges. The ends or short sides of the 4-in. piece are bent up at right angles to the surface and in the opposite direction to the tabs.

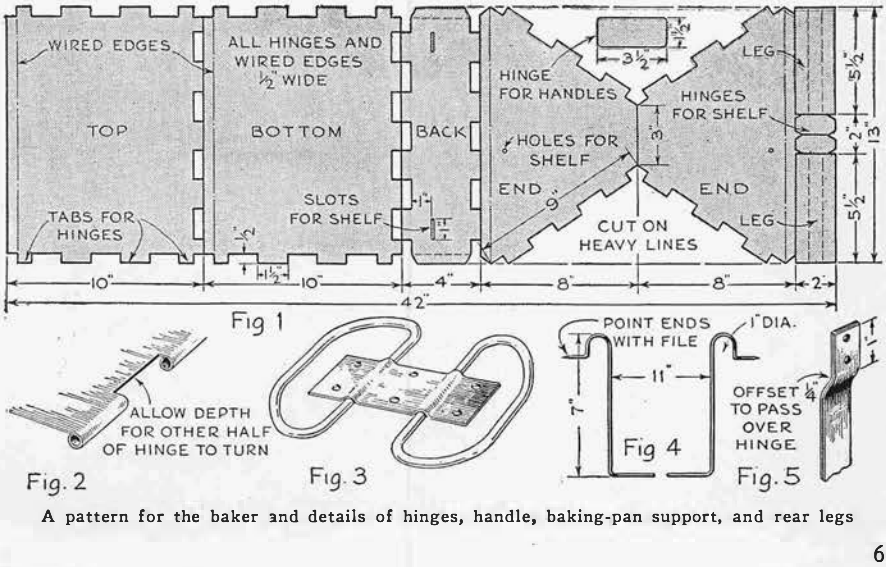
Two of the 12-in. wires are pointed on one end, and a ring about 1 in. in diameter is formed on the other. These two wires are removable to allow the baker to be folded for carrying.

The 2-in. wide pieces of tin are bent into three thicknesses each and drilled and offset as in Fig. 5 to form the rear legs. Rivet these in place about 2½ in. from the sides of the back.

The support or shelf for the baking pan is made from the 30-in. length of wire as in Fig. 4. Bend two pieces of tin around the wire and pinch them together so that the ends can be inserted in the slots previously cut in the back. When the wire is down snug against the back piece, bend the ends of the small pieces over against the back and hammer down. Set baker in position, lift shelf until horizontal, mark position of wire points on sides of baker, and drill holes. Spring shelf apart slightly at front so that the wire will snap into the holes.

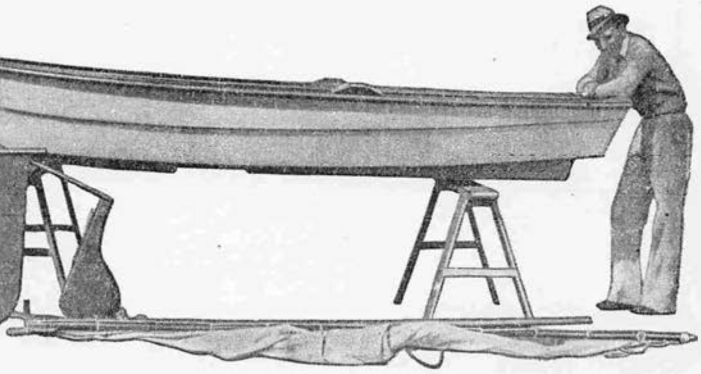


The hinge tabs are bent over a piece of wire



A pattern for the baker and details of hinges, handle, baking-pan support, and rear legs

BUILDING A General



HERE is a rowboat that is in a class by itself—the final development of a long line of forerunners. This graceful little V-bottom craft is 13 ft. long, carries from four to six passengers, rows easily, sails like a charm, and may be powered with a small outboard motor of from 2 to 12 H.P. for fishing, camping or high adventure. The construction is relatively simple and the cost of materials low—not more than $30 at most.

Mate has been tested under all conditions and is exceptionally seaworthy and dry in choppy seas. The lap-strake construction makes the hull rigid and insures that it will remain water-tight even when the boat is taken out of the water and put in again at infrequent intervals. The boat weighs from 175 to 190 lbs., depending upon the materials, and consequently may be transported easily by trailer.

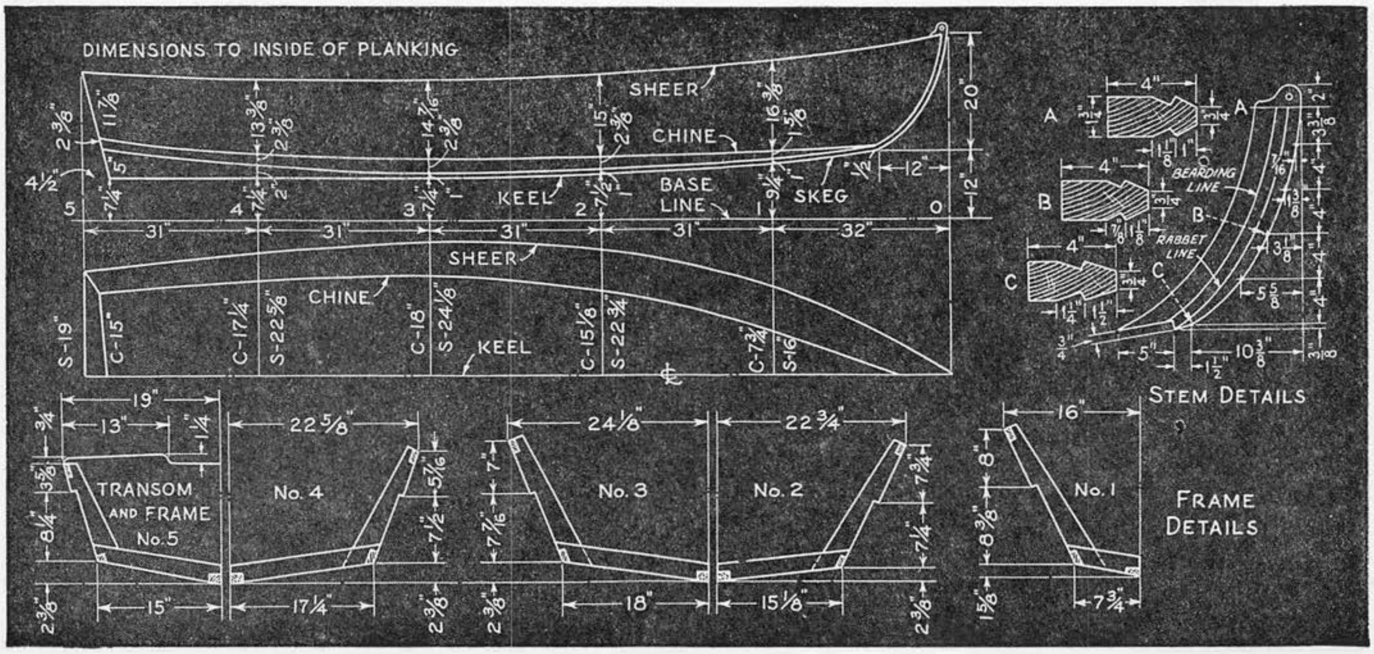
Before starting the construction, study the plans and list of materials carefully. Although this hull has already been laid down full size on paper, many times a better conception of the boat as a whole may be had by the builder if he does this work himself. Incidentally, patterns of the stem, breast hook, skeg, and transom knees may be taken from the full-size layout.

The 2 by 10 in. by 12 ft. form upon which the hull is built should be shaped and notched out for the frames as shown. Mount the form upon wooden legs similar to a sawhorse and high enough to be convenient.

Make full-size paper patterns of the stem and frames. Lay them on the ¾-in. frame material and the 1¾ by 8 by 27 in. stock for the stem. Prick the outline through by driving brads and removing them or by using a dressmaker's toothed wheel. Connect the marks with pencil lines. To allow for beveling, leave the top edge of side members marked Nos. 1 and 2 fully ½ in. wider. This edge will then measure 2 in. Saw the frame parts and stem to shape and trim the edges evenly.

Lay the side and bottom frame members on the paper patterns so as to conform to the outline, and bolt together with two 2 by ¼ in. carriage bolts at each joint. Before fastening, coat the adjoining surfaces with casein glue. Nail ¾-in. wood strips across the frames to hold the shape.

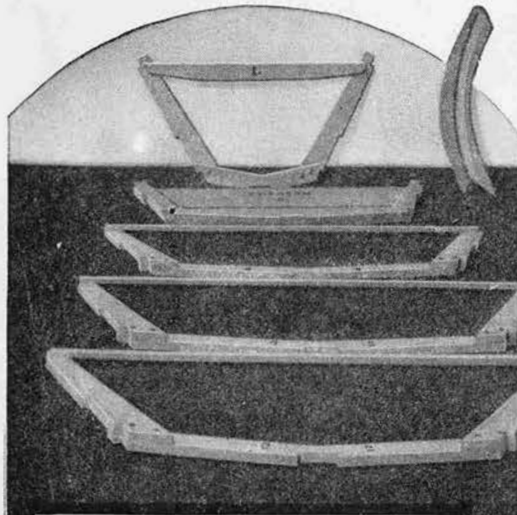
The stem is now carefully beveled and rabbeted as shown in the three details. Cut the rabbet ½ in. deep, using a piece of planking with the edge cut square as a depth gage.

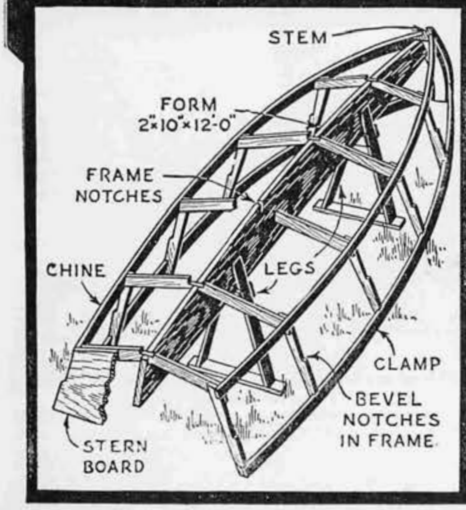


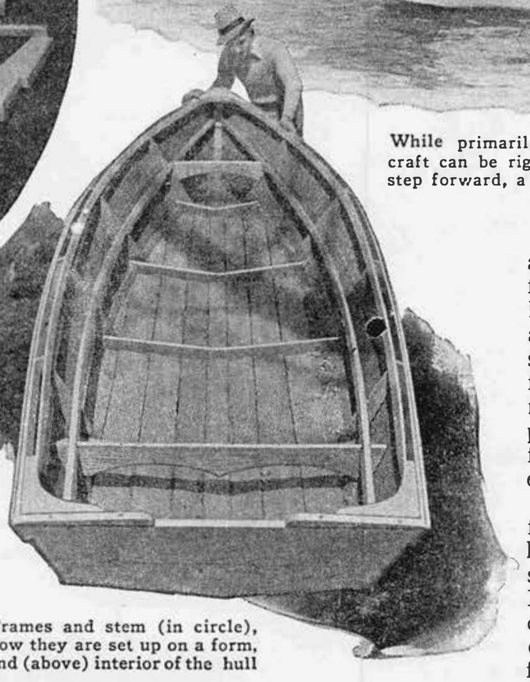
Utility Rowboat

AN IMPROVED DESIGN FOR AMATEUR BUILDERS . . TAKES SAIL OR MOTOR

While primarily a rowboat, this stanch little craft can be rigged for sailing. There is a mast step forward, a small centerboard, and a rudder



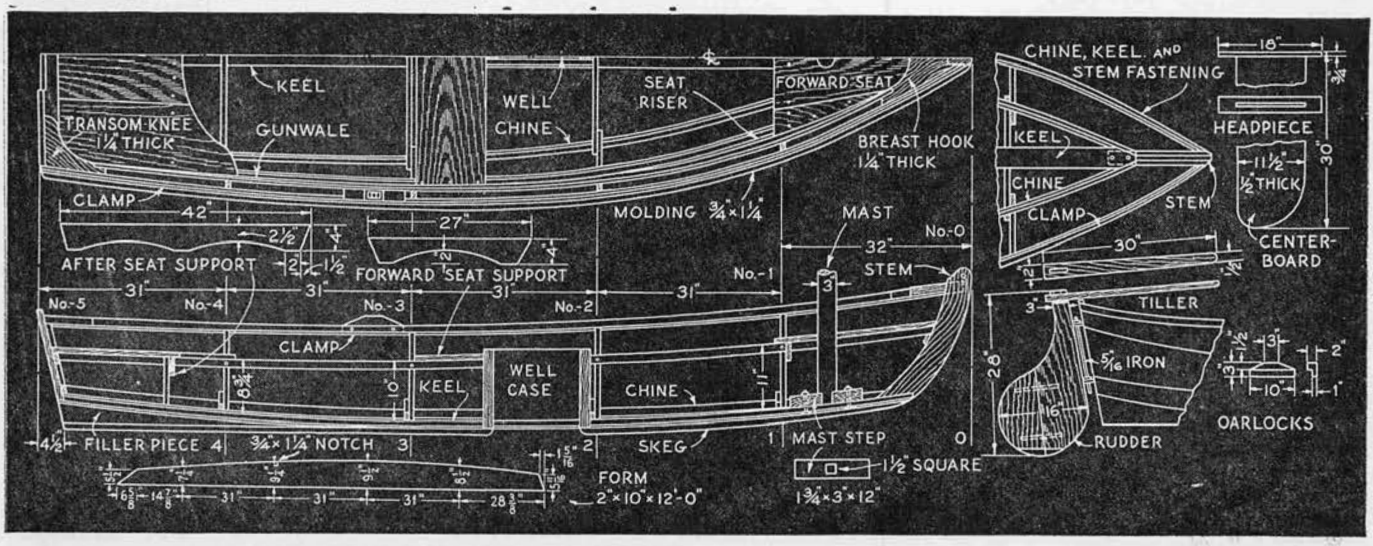




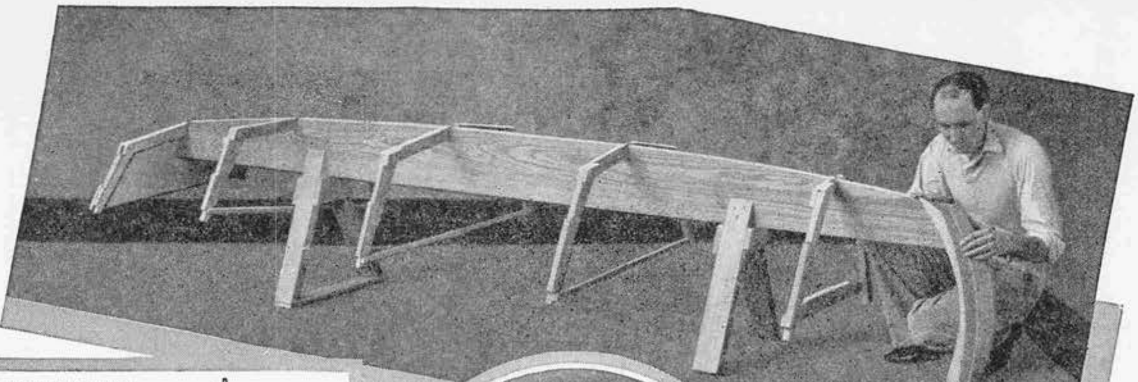
Frames and stem (in circle), how they are set up on a form, and (above) interior of the hull

Clamp the stem to the form and temporarily assemble the frames on the form. Bend a light batten around the frames, and mark the bevel on the outside frame edges. Remove frames and bevel edges. Cut the notches for the clamp, keel, planks, and chines in the frames, following the bevel on each frame.

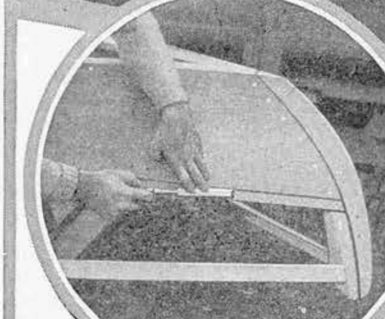
Replace the frames on the form and fasten the ¾ by 3 in. keel to each frame and to the stem with two 1¾-in. No. 8 F.H. (flathead) screws. Incidentally, galvanized screws are cheaper and will serve as satisfactorily as brass.



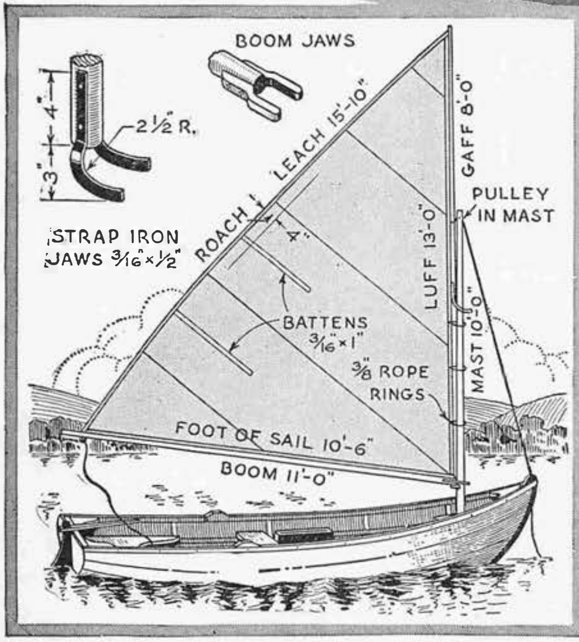
Top and side views of the boat; how the chines, keel, and stem are fastened; details of the centerboard, rudder, oarlocks, mast step, and construction form; and, on the facing page, the general layout and details of frames and stem. See the list of materials for dimensions of stock

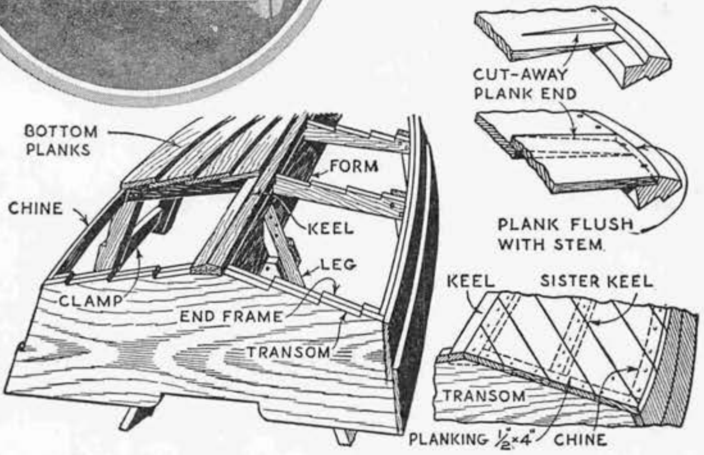


The frames are set up on a notched form made as shown in the drawing at the bottom of the preceding page. This form is placed on legs like a sawhorse at a convenient height for working in comfort

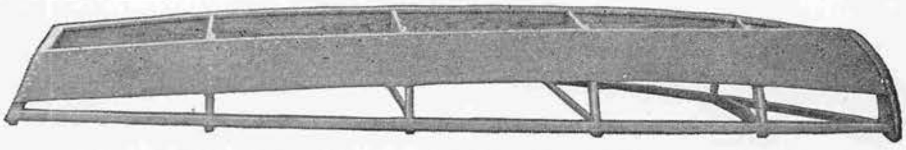


As the boat is of lap-strake design, the planks are overlapped except at the stem, where both planks are chiseled out to allow the upper to come flush with the stem, as shown at left and below





The sail plan and, at right, how the side planks are fitted at stem and two methods of laying the bottom planking—lapped or laid diagonally with butt joints



The first side planks are sawed from a board 12 in. wide so that they fit the frame notches accurately

Square and line up the frames, and clamp the ¾ by 1½ in. chines in place. Fasten the chine to each frame with one 2-in. No. 10 F.H. screw. Fit the forward ends against the keel and fasten with one 1¾-in. No. 8 F.H. screw on each side. Fasten both chines simultaneously.

Square and line up the side members, clamp the ½ by 1½ in. clamp piece in place, and fasten to each frame with one 1¼-in. F.H. screw. Fit the forward ends to the stem, just behind the rabbet, and fasten with two 1¼-in. No. 8 F.H. screws.

Trim and fair the entire frame, planning all joints down so the planking will fit evenly.

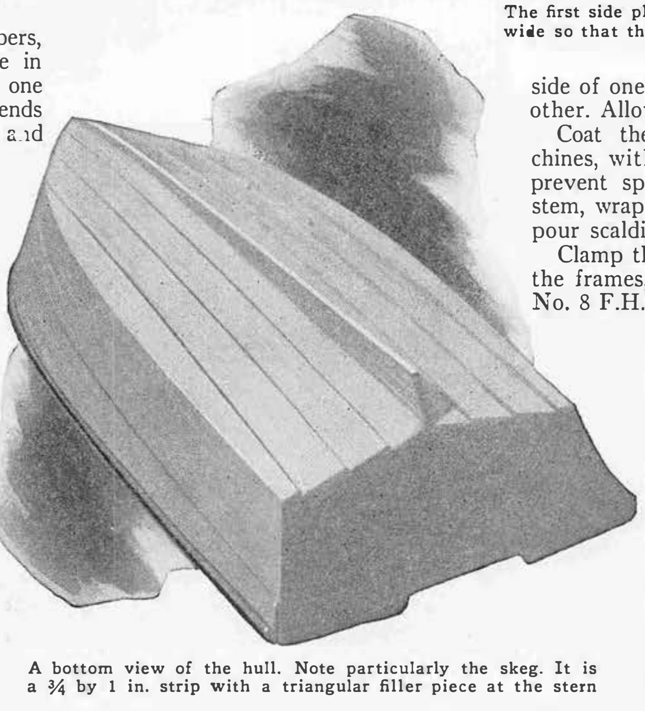
The planks on each side next to the chines are attached first. Clamp a ½ by 12 in. by 14 ft. plank in place so it fits the frame notches snugly. Carefully measure and fit the forward end in the stem rabbet. Mark along the chine edge, remove, and saw to shape.

To make the side and bottom planks fit flush together at the forward ends, a rabbet joint is cut with knife and chisel as shown. The depth of the rabbet runs from nothing 24 in. back from the end to half the thickness of the planking at the outer end. The cut will be on the outside of one plank and on the inside of the other. Allow 1 in. for plank lap.

Coat the stem rabbet, transom, and chines, with "C" quality marine glue. To prevent splitting the side planks at the stem, wrap the forward ends in sacks and pour scalding hot water.

Clamp the plank in place and fasten to the frames, stem, and chines with 1¼-in. No. 8 F.H. screws spaced at 2½-in. intervals. Fasten the other side similarly. The planks next to the clamp piece are now fitted. Before fastening them, coat the lap, stem rabbet, frame edges, and clamp with marine glue. Fasten the lap together and fasten the plank to the clamp with 1¼-in. iron or copper clout nails, spaced 2½ in. on centers, clinching nails on the inside. Drill lead holes for all nails and screws.

If considered desirable, short lengths of planking may be used at an angle to make



A bottom view of the hull. Note particularly the skeg. It is a ¾ by 1 in. strip with a triangular filler piece at the stern an easily built but stout bottom by the alternative method shown on the plans. The regular lap-strake bottom planking, however, is attached as follows: The two center planks are the only ones requiring fitting. Mark a center line on the keel. At frame No. 3 clamp the first plank in place so the edge is even with the center line. The forward and after ends will overlap. Measure, mark, and saw off the surplus so the plank edge fits even with the center line. Bevel the center seam edges and allow a 1/16-in. seam. Clamp the plank fore and aft, edge even with center line, and mark each frame along the outside edge. Remove the plank and make a saw cut ⅜ in. deep on the outside frame mark. Chisel out frame and transom notches as shown. Cut the plank notch at frame No. 1 to a depth of 3/16 in. Coat the keel, transom, and chines with marine glue. Clamp planks in place and fasten to the keel, chines, frames and stem with 1¼-in. No. 8 F.H. screws, spaced 2½ in. apart. The forward ends of the planks are lapped in a manner similar to the side planks. Countersink screws along the keel to allow for planing so the skeg will fit evenly.

List of Materials

LUMBER

Planking: Sides, 2 pc. ½ by 12 in. by 14 ft. and 2 pc. ½ by 10 in. by 14 ft.; bottom, 2 pc. ⅜ by 6 in. by 8 ft., 2 pc. ⅜ by 6 in. by 10 ft., 2 pc. ⅜ by 6 in. by 12 ft., white pine, cedar, cypress, or mahogany.
Frames: 1 pc. ¾ by 6 in. by 14 ft.. 1 pc. ¾ by 6 in. by 8 ft., oak, spruce, fir, or mahogany.
Transom: 1 pc. ¾ by 8 in. by 8 ft., oak or mahogany.
Floor boards: 2 pc. ¾ by 6 in. by 10 ft., fir or yellow pine. Saw in two pieces and resaw to make eight pieces.
Seats, well, and rudder: 2 pc. ¾ by 12 in. by 10 ft., white pine, cedar, cypress, mahogany, or redwood.
Centerboard: 1 pc. ½ by 12 in. by 3 ft., white pine, cedar, cypress, mahogany, or redwood.
Breast hook and transom knees: 1 pc. 1¼ by 12 in. by 3 ft., oak.
Oarlocks and mast step: 1 pc. 2 by 4 in. by 3 ft., oak, fir, or yellow pine.
Stem: 1 pc. 1¾ by 8 by 27 in., oak.
Sheer molding: 2 pc. ¾ by 1¼ in. by 14 ft., oak, fir, or yellow pine.
Seat supports (forward and after): 1 pc. ¾ by 4 in. by 6 ft., fir, yellow pine, oak, or spruce.
Centerboard posts, seat legs, and ledge: 1 pc. ¾ by 1½ in. by 8 ft.
Chines: 2 pc. ¾ by 1½ in. by 14 ft., oak, spruce, fir, or yellow pine. Use the same wood for all the following five items.
Clamps: 2 pc. ½ by 1½ in. by 14 ft.
Gunwales: 2 pc. ½ by 1¼ in. by 14 ft.
Seat risers: 2 pc. ¾ by 1¼ in. by 14 ft.
Skeg: 1 pc. ¾ by 1 in. by 12 ft.
Skeg filler piece: 1 pc. ¾ by 4 in. by 6 ft.
Keel: 1 pc. ¾ by 3 in. by 14 ft.

FASTENINGS

5 gross 1¼-in. No. 8 F.H. (flathead) brass or galvanized screws.
2 doz. 1¾-in. No. 8 F.H. brass or galvanized screws.
5 doz. 2-in. No. 10 F.H. brass or galvanized screws.
½ lb. 1¼-in. copper or iron clout nails.
½ lb. 1-in. copper or iron clout nails.
16 carriage bolts, 2 by ¼ in.
6 carriage bolts, 3½ by ¼ in.
4 large screw eyes for rudder, and 1 pc. 5/16-in. rod 15 in. long.

MISCELLANEOUS

1 pr. oars 7 ft. long.
1 set oarlocks and sockets (North River style).
¼ lb. casein glue.
1 qt. "C" quality marine glue (liquid).
½ gal. paint for outside.
½ gal. paint or varnish for inside.
Small quantity white lead.
Strips of cloth.

FASTEN the remainder of the planking in like manner, allowing 1 in. for plank lap. Fasten the lapped edges together with 1-in. iron or copper clout nails, spaced 2 in. apart. Hold an iron on the underside while clinching. Before fastening a plank, thoroughly coat the lap with marine glue and place 1 in. wide muslin tape over the glued area. This insures a permanently water-tight joint.

The ¾ by 1¼ in. seat riser is fastened to the frames at the height shown, with one 2-in. No. 10 F.H. screw at each joint. Slightly notch the frames for the riser. Nail a small block to the stem directly under the ends of the risers, and nail risers to block. Fasten the after and forward seat supports in place with 1¼-in. No. 8 F.H. screws. To hold the rear seat support, ¾ by 1½ in. legs are screwed to the support and chine with 1¾-in. No. 8 F.H. screws. The after edge of the transom seat is supported with a ¾ by 1½ in. piece screwed to transom. Bolt the mast block through the planking and keel with two 3½ by ¼ in. carriage bolts. Shape the seats as shown and fasten to the supports and seat riser with 1¼-in. No. 8 F.H. screws. Saw a circular hole in the forward seat for the mast directly over the mast block. The center of the mast should be 24-in. back from the top edge of the stem.

The breast hook and transom knees are now marked out on the 1¼-in. stock and sawn to shape. Cardboard patterns used as templates will eliminate much of the fitting. The breast hook should be slightly curved on top. Fasten in place with six 2-in. No. 10 F.H. screws, and use four screws to each transom knee.

THE ½ by 1¼ in. gunwale is fitted and fastened to the breast hook, frames, and transom knees with 1¼-in. No. 8 F.H. screws. Bevel the top edges of frames Nos. 1, 2, and 3 so the gunwale fits evenly.

The sheer molding is a piece ¾ by 1¼ in. with the edges rounded. Fasten to the sheer with 1¼-in. No. 8 F.H. screws spaced 6 in. apart.

Bolt each oarlock through the sides as indicated with two 3½ by ¼ in. carriage bolts. Fit oar sockets and fasten with 1¼-in. No. 8 F.H. screws.

For the well, saw a ¾-in. slot about 18 in. long through the keel and planking, from the after side of frame No. 2 to a point where the forward edge of the middle seat is over the other end of the slot. Two supports ¾ by 1½ by 16 in. are now coated with white lead or marine glue, and driven into each end of the well slot. Screw the forward post to frame No. 2 and the afterpost to the edge of the seat. Fit the ¾ by 12 in. well sides to the keel and posts. Liberally coat the bottom edges with white lead or glue, and clamp to the posts. First fasten the well boards from the bottom up, with four 2-in. No. 10 F.H. screws in each board. Fasten them to the posts with 1¼-in. No. 8 F.H. screws spaced 1½ in. apart.

Turn the hull over and plane the center seam flat so the skeg will fit evenly. Thickly smear white lead in seam. Fasten the skeg filler piece from the inside with four 2-in. No. 10 F.H. screws. The ¾ by 1 in. skeg is now fastened to the filler piece and to the center of the keel with 2-in. No. 10 F.H. screws spaced 8 in. apart. Saw the skeg off at each side of the well slot, and bevel the skeg out to ⅜ in. at the stem.

Fasten the 5/16 by 2⅝ in. floor boards to the frames as shown, separated ¾ in., with 1¼-in. No. 8 F.H. screws. Provide short center supports between frames for the floor boards.

Sand the entire hull smooth. The seats and inside are varnished or painted as desired with three coats. The sides and bottom should be painted with three coats of good lead and oil paint. Sand lightly between coats.

The mast should be made as shown, 10 ft. long, tapering from 3 to 2 in. Saw it square on the bottom to fit the mast block. The boom and gaff may be sawn from a 2 by 6 in. plank. The boom is 11 ft. long, 1¾ in. in diameter; the gaff 8 ft. long, tapering from 1¾ to 1¼ in. Use spruce, fir, or yellow pine for the spars. Saw them out square, then shape them round with plane and sandpaper.

The sail requires 10 yd. of closely woven muslin or sheeting. Sew a ¼-in. cotton rope inside the outer hemmed edge to prevent stretching. To lace the sails to the spars, insert ¼-in. grommets every 10 in. on the boom and every 12 in. on the luff. Use four ⅜-in. rope rings on the mast, and lace the remainder of the sail to the spars with ¼-in. cotton rope. Use ¼-in. or 5/16-in. rope for the halyards.

The rudder, made as shown, is attached to the hull by fastening screw eyes to the transom and rudder, through which a 16 by 5/16 in. iron rod is dropped. Shape the rudder handle from a ¾ by 2 by 30 in. piece of oak, and bolt to the rudder.

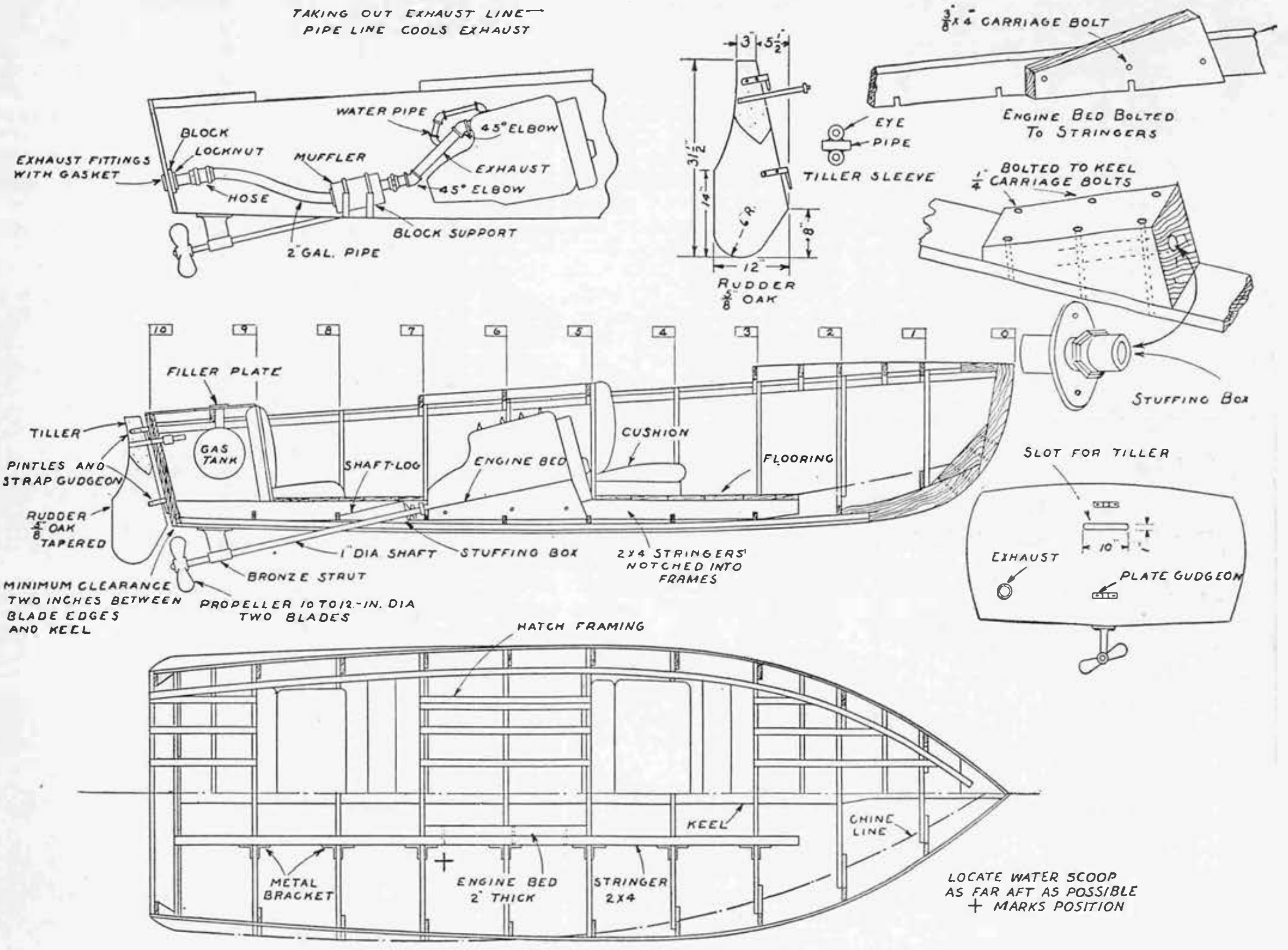
The ½-in. dagger type centerboard is merely pushed through the well. A ¾ by 2¼ by 18 in. headpiece is notched all the way through and is screwed to the centerboard.

HOW TO WIELD A GLASS CUTTER SUCCESSFULLY

IN USING a glass cutter, the glass should rest in perfect contact with its supporting surface—for example, a bench or table well padded with newspapers. Place the hollow side of the glass down if there is any noticeable difference. Hold the cutter vertically, use a firm, steady pressure, and make one cut only. If the glass does not break easily, tap lightly with the cutter holder along the cut on the under side of the glass, or rest the cut over any convenient straight edge and break the piece off with gentle pressure.

When it is necessary to cut an outside curved edge, lay the glass over the desired curve drawn on a piece of paper, make several cuts, say ½ in. apart outside of the curve, and break the glass away. Now make the final cut over the curve. If an inside curve is being cut, make the correct cut and another, say 3/16-in. inside of it. Then make V-cuts in the waste glass and break the glass away with the slots in the cutter handle or with flat-jawed pliers, unless it breaks away easily otherwise.

Installing Inboard Boat Motors



HOW TO MOUNT MARINE AND CONVERTED AUTOMOBILE ENGINES

TO GET the best results from any motor boat, it is essential that the power unit be properly installed in the hull, whether it is a regular marine engine or a converted automobile engine. A secure foundation for the motor is the first requirement. The strain and vibration is distributed over the entire hull by the installation of two yellow pine two-by-four stringers. These are notched into the frame, and attached with angle-iron brackets.

The point to locate the motor varies with different hulls. On small runabouts, for example, the engine is placed by locating the center of gravity, and putting the flywheel, or forward, end of the motor even with this point. If there is any doubt, it is far better to have the engine too far aft than too far forward. The center of gravity is easily found by balancing the hull on a piece of two-by-four. By moving the hull back and forth, a point of perfect balance will be found.

Much time and trouble will be saved if a full-size drawing of the hull is made. The point of balance is found, and marked on the drawing. By marking the measurements of the engine, and the propellor clearance, and allowing for the depth of the oil pan, a drawing can be made of the actual installation. From this all measurements for the engine bed, shaft log, and point where shaft enters keel, can be transferred to the hull with the certainty that everything will fit properly.

The 2-in. thick engine beds are bolted to the stringers with ⅜-in. carriage bolts. The shaft log is sawed from oak, its bottom smeared with thick paint, or marine glue, and bolted to the log or keel with six ¼-in. carriage bolts. A piece of canvas or thick flannel is laid between the two parts before assembly.

In boring the hole for the shaft, allow a ⅛-in. clearance. If desired, a neater and better job can be had by installing an adjustable metal shaft log. This is merely bolted to the keel, and automatically takes up any difference in shaft angle.

To prevent the shaft from binding, shims consisting of small blocks, or pieces of sheet metal may have to be placed under the engine bearers to set the engine at the proper level. The outside of the shaft is held rigid with a bronze strut of either the adjustable or rigid type. Bolt strut to keel, being careful that the shaft does not bind.

The end of the propellor shaft is threaded and slotted for a keyway. A cotter-pinned nut securely attaches the propellor. Propellors, for best results on modern, high-speed motors and boats, should be of the two-blade type, from 10 to 12 in. in diameter.

The outside rudder installation is used to reduce the angle of propellor shaft and engine installation. This is important with marine engines, and especially so with converted automobile engines. Saw the rudder from ⅝-in. oak, and taper nicely. Fasten with pintles and strap gudgeons, purchasable at any marine supply house.

The exhaust is cooled by tapping part of the circulating water into the exhaust line with ½-in. galvanized iron pipe. The exhaust is taken out as indicated. The muffler is supported on wooden blocks cut to shape as shown, and fastened to the hull. Circulating water is conducted through the side of the hull with ½-in. galvanized pipe.

Locate the water intake close to the keel as far aft as possible. A standard marine intake scoop placed on the hull immediately over the intake pipe will materially increase the circulation.

PEPPING UP YOUR
Outboard Motor

HOW TO OVERHAUL IT SO AS TO INCREASE THE SPEED FROM TEN TO TWENTY PERCENT

YOU can get much greater speed from an outboard motor, whether of the racing or service type, if you keep it well tuned up. "Pepping" or "souping" are two of the colloquial terms applied to this process. Properly done, it yields a power increase of from ten to twenty percent.

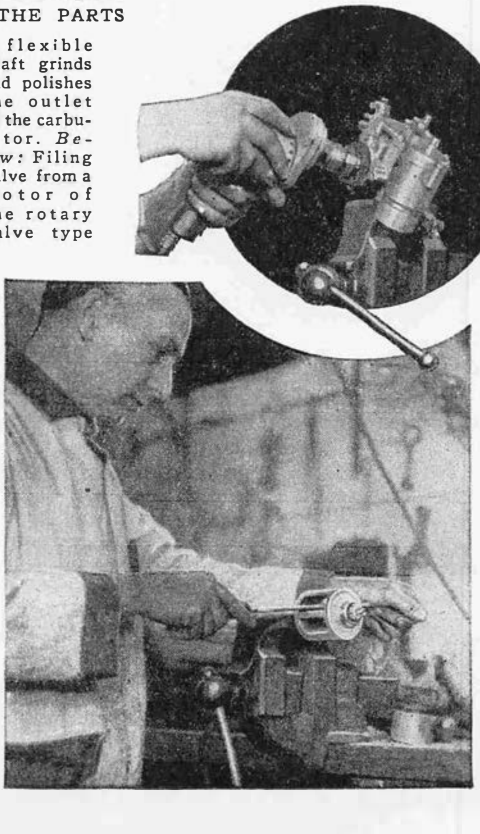
The methods that follow are for the amateur racing enthusiast, to whom 100 R.P.M. more or less may mean a race lost or won, but any outboard owner who likes mechanical work will also profit by having a faster motor for fishing or general service. After being tuned up, the motor will still pass inspection at sanctioned regattas, yet it will deliver a real wallop at the propeller end.

Dismantle the motor and place each part in a pan or box with its component nuts and bolts.

Balance and low frictional losses are two of the most important factors for speed. Therefore, to increase the volume of the gas and to reduce the retardation of the gas flow caused by the rough interior surface of the intake and intake ports, the entire passage from the carburetor to the cylinder combustion passages should be ground smooth and polished to as flawless a finish as obtainable.

SMOOTHING THE PARTS

A flexible shaft grinds and polishes the outlet of the carburetor. *Below:* Filing valve from a motor of the rotary valve type



For smoothing and polishing the intake passages, an excellent way is to use an electric hand drill or motor with a flexible shaft equipped with small grinding stones of different sizes and a buffer. This equipment may usually be borrowed from a garage, or you can have the work done there inexpensively. Lacking this equipment, a good job may be done with files of various shapes and lengths and fine emery paper.

Start by grinding and polishing the carburetor outlet. Remove the butterfly valve from the carburetor, solder each end of the shaft, and cut away the middle portion of the shaft to allow freer gas flow as shown in one of the sketches. The intake passages up to the cylinder combustion bypaths or ports are now ground or filed smooth and polished. Some motors have a small lip dividing the intake port. Do not cut this away, but carefully grind and polish on each side.

Remove the valve of rotary valve motors, file, and polish smooth with fine emery cloth, or use the electric drill with a buffer and buffing compound.

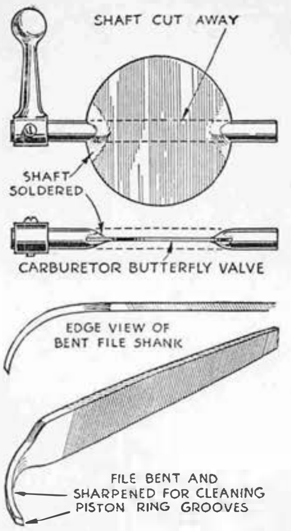
After grinding and smoothing, thoroughly clean all the gas passages, including the important intake and cylinder ports.

Remove pistons from the connecting rods and examine for prominent bright spots caused by rubbing or metal-to-metal contact. Dress these spots down carefully with a fine file. The removal of .001 to .002 in. is generally sufficient.

Whether the motor is old or new, remove the rings and free the grooves of carbon. Use care to avoid enlarging the grooves. A bent file, sharpened as shown in one of the sketches, is a good tool for this purpose. Whenever the motor is dismantled, new soft rings of any good brand should be used to replace the old ones. Soft rings seat quickly and require very little running in. Assemble the rings on the piston and proceed to balance the assembly.

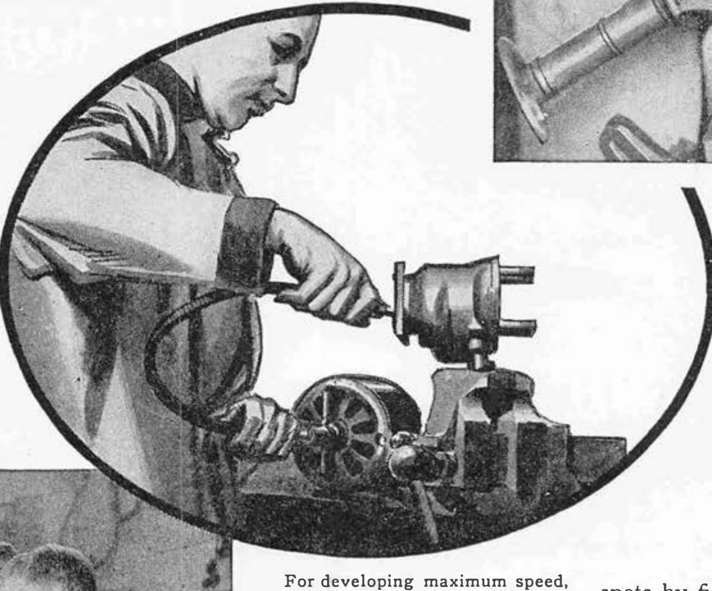
Use a jeweler's or druggist's scale to balance the piston assembly, consisting of piston, rings, and wrist pin. For best results, balance pins and pistons separately. If one piston is found to be heavier, the weight is adjusted by filing away sufficient metal from the piston head so as to balance perfectly.

The piston assembly is now replaced on the connecting rod, and the cylinder refastened. As the cylinders on certain class "A" motors using one cylinder block for both pistons are difficult to replace, it will be found easier to fit one piston well up in the block before attempting to fit the other. Tighten the cylinder bolts.

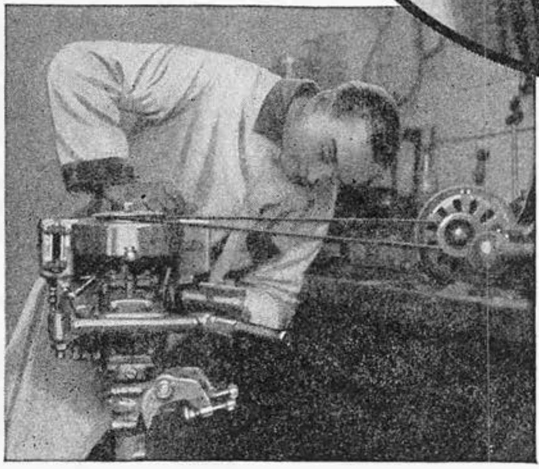

SHAFT CUT AWAY
SHAFT SOLDERED
CARBURETOR BUTTERFLY VALVE
EDGE VIEW OF BENT FILE SHANK
FILE BENT AND SHARPENED FOR CLEANING PISTON RING GROOVES

How butterfly valve of carburetor is modified, and a tool for scraping grooves in piston

To replace piston assemblies in a cylinder block like this, set one piston well up in the block before fitting the other



For developing maximum speed, all the gas passages must be carefully ground and polished



The reassembled outboard is belted to an electric motor and run in with a mixture of thin oil and some very fine abrasive

Clamp the outboard in a convenient position and belt an electric motor to it as shown. Obtain one pint of light, thin oil, and add to this a handful of a scratchless type of household cleaning powder or, better yet, jeweler's rouge. Place the mixture in a squirt oil can. Run the motor for 25 or 30 minutes while constantly introducing this mixture through the spark-plug openings. This seats and polishes the pistons, rings, and cylinders. Next remove the cylinders and give the crank shaft, cylinder interior, pistons, and bearings a thorough bath with gasoline. Be sure that every trace of the polishing mixture is removed.

Now for the final assembly. New gaskets, of course, must be provided. Before replacing the cylinders, enlarge the various stud bolt holes very slightly by reaming. The reason for this will be shown. Squirt light oil on the piston assembly and bearings, and rebolt the cylinders. Do not tighten the cylinder nuts, however.

Obtain a small electric motor with just enough power to run the outboard motor, or use a 1/4-H.P. motor with a milliammeter inserted in the line. With the pulley of the motor belted to the outboard flywheel, start the electric motor. Now shift the cylinder block around on the crank shaft. It will be found that at certain points the electric motor will speed up or the milliammeter reading will drop, due to the decreased load. Securely fasten the cylinder nuts at this point, as this is the point of lowest resistance or friction.

Reassemble the motor with the exception of the lower unit. The gear cover of the lower unit is removed and the gears and interior given a thorough cleansing. Hot water will effectually loosen the old grease, which is then washed out with gasoline. Examine gears and shafts for any spots that may cause binding. Remove high spots by filing carefully.

For racing, replace the gear lubricant with light oil to which has been added a quantity of powdered graphite. Inspect after every race. For service work, auto oil like 600W is all right, or the regular outboard grease sold in tubes. Inspect and replace gear lubricant periodically. Provide new gaskets before replacing the lower unit. To reduce water resistance still more, file the edges of the skeg and cavitation plate to a sharp edge, and buff the lower unit or polish with steel wool. Remove dents and nicks from the propeller, and file the edges sharp.

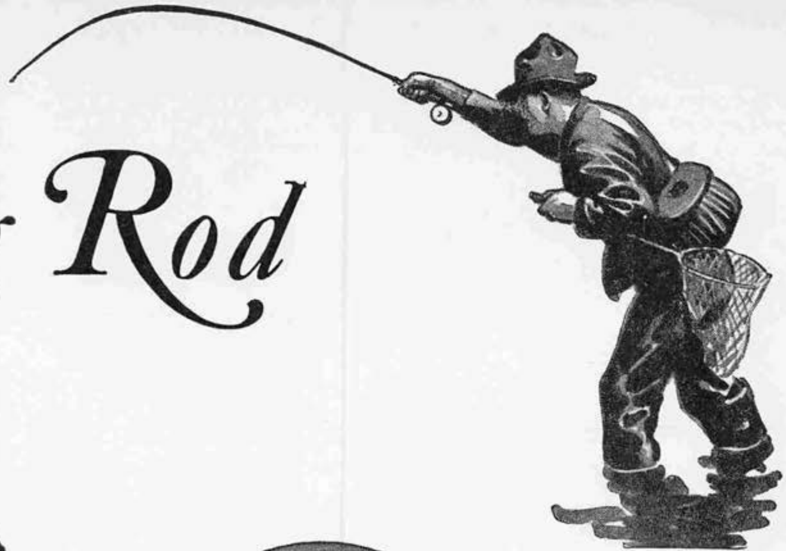
For racing service do not use an unnecessarily large proportion of heavy lubricating oil in the gasoline, as this causes piston drag with a consequent loss in R.P.M. Experiment will show the correct proportions of oil and gas. Special fuels are now available for a power increase of from 200 to 300 R.P.M., but they are rather expensive.

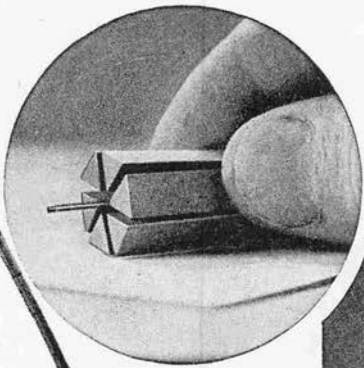
Better results may often be had on racing hydros by raising or lowering the motor or altering the angle of the motor on the transom of the boat. Choose the correct plugs for racing use.

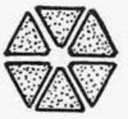
Sharpen the leading edges of the fin, and for a frictionless boat bottom, smooth the finish with fine sandpaper and polish it with furniture or auto wax.

Homemade Casting Rod

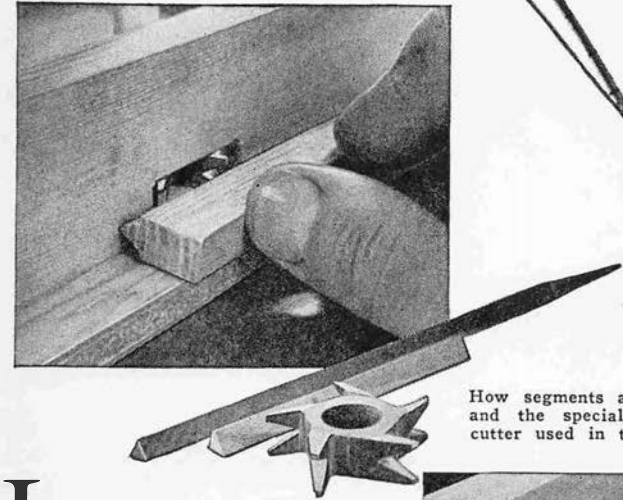
MADE STRONGER BY WIRE CORE





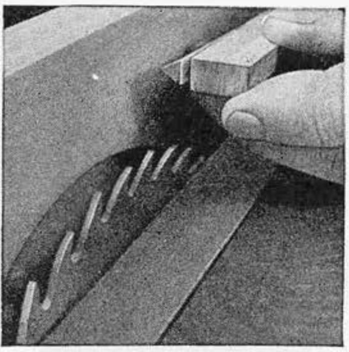


A rod made by this method is remarkably strong, flexible, and tough. The exact size of the segments is shown at the left. *In circle:* How they are put together



How segments are shaped, and the special V-shaped cutter used in the process

To obtain uniform pressure when binding the segments, a weight is hung on the cord and the glued-up rod is revolved slowly and evenly



After one edge of each strip has been shaped with the cutter, the piece is ripped on a circular saw

IT'S GREAT sport to cast for the big ones with a rod you have made yourself. This one is tough, flexible, and springy. The important parts can be made on a drill press if you haven't a shaper. The rod consists of six strips of hickory and osage orange, alternating, with a length of stiff piano wire for the core.

In choosing the wood, get strips 40 in. long, several inches wide, and ⅜ in. thick. The hickory should be well seasoned—preferably a piece that has dried naturally for several years instead of being kiln-dried. Select yellow osage orange, so popular in making archery bows; the white part, from near the bark, is not so strong.

If a V-shape cutter is not available, it may readily be made from a blank. The angle of the cutters is the same as that of a triangular file. After passing the strip against the cutter as shown, the triangular piece is cut off on the circular saw to give 40 in. long segments of exactly the size shown in the diagram. If the triangular strips are of this size, they will, when assembled, accommodate a music-wire core of No. 19 standard gage. The inside edge of each segment may be very slightly trimmed down if larger wire is used. Music wire of any size from No. 18 to 21 (standard gage) or No. 12 to 15 (music-wire gage) may be used according to the flexibility desired.

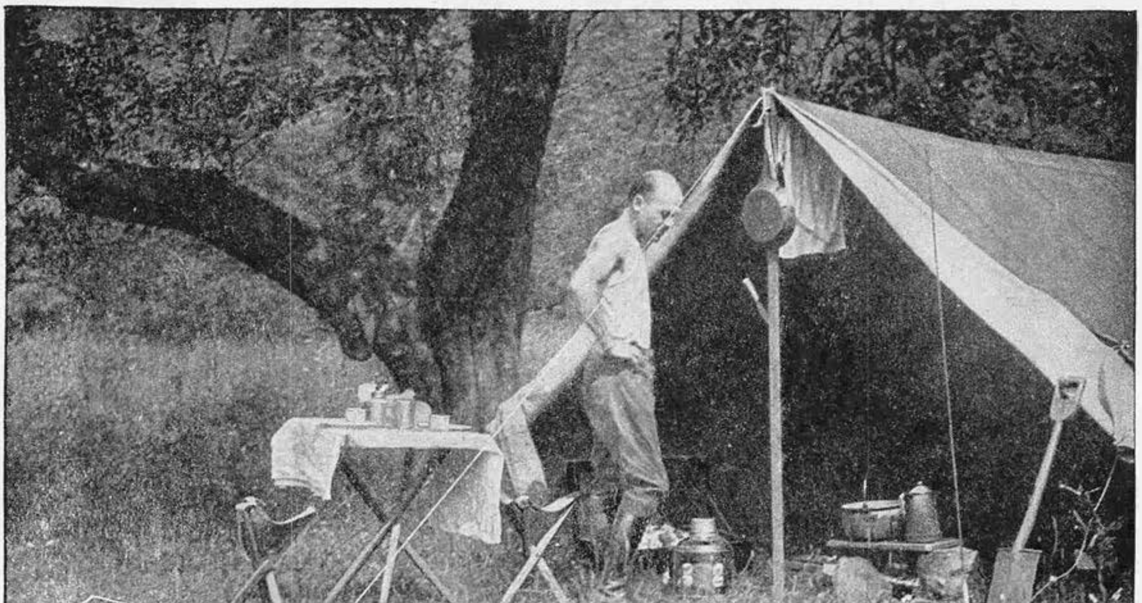
The segments are assembled with the piano-wire core as illustrated. Apply thick waterproof casein glue and wrap with a heavy cord. In wrapping, it is essential that the pressure be applied evenly. By hanging the cord to a weight and slowly turning the glued-up rod, this can be easily done. Allow the glue to harden for two days.

The next operation consists in tapering the rod on the jointer or with a plain shaper cutter. Set the blade to remove the thinnest possible shaving. Pass the rod over it six times (once for each segment); then repeat again and again, each time cutting down less and less of the rod until it acquires a very gradual taper. The point should taper down to about ⅛ in. diameter, leaving the thick end with a diameter of about 7/16 in. Round the latter with sandpaper to fit loosely in the handle.

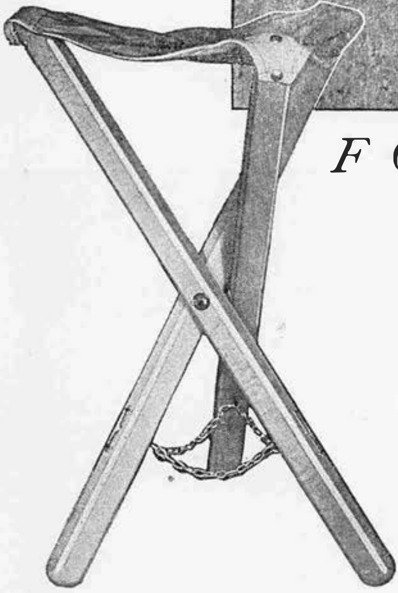
Place some very thick waterproof casein glue in the socket of the handle. When the rod is pushed in, all excess glue will be expelled and may be wiped off. The joint may be further refined in appearance by smoothing with a little composition wood.

The regular hardware (tip, guides, grip, and reel) may be purchased or taken from an old rod. The next step is to wind the rod with an even layer of fine silk thread. Give the windings a very light coat of shellac before varnishing. The latter operation should be done while the rod is suspended by the tip, and it is preferable to use a number of coats of thin, high-grade weatherproof varnish than several coats of thick varnish.

The colored segments give the rod an attractive appearance, and it has proved its value during much strenuous fishing.



The folding table and chairs are not only useful for camping, but also for an occasional picnic or auto trip. Light as they are, the seats will support a man who weighs 200 lb.



FOLDING CAMP TABLE

A FOLDING table-and-chair set that will serve for a prolonged camping trip or automobile tour as well as for an occasional picnic can be made in the most modest workshop. It consists of a sturdy table 24 in. square and four seats, all of which can be packed in a container 8½ by 9 by 24 in. Poplar or white pine will serve for the material, although hardwood may be used to advantage for the legs of both the chairs and the table.

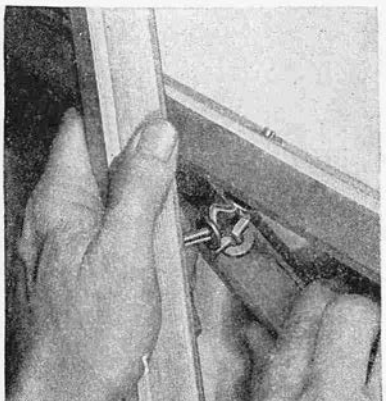
The seats are each made from three pieces of 1¼-in. square wood, 24 in. long. Drill a 7/32-in. hole in each piece, 12 in. from the end. Take three split cotter pins 3/16 by 2 in. and bend them as shown. Then lay them in the form of a three-pointed star, the three points being equidistant and radial. Slip a ¼-in. cut washer onto each point and assemble the three legs. Place another ¼-in. washer against the other side of each leg and split the pins—that is, bend the ends apart like an ordinary cotter pin. The washers will prevent the legs from wearing from friction.

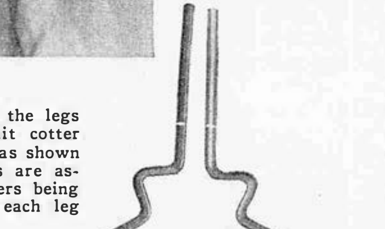
The legs should lie close together when the seat is closed and they should swivel into position easily. Swivel the legs so that their upper ends are about 14 in. apart and anchor the lower ends with a piece of light sash chain, fastened 3 in. from the lower end of the legs. The chain may be secured with staples, but the better method is to drill the legs and use ⅛ by 1½-in. cotters. The upper ends of the legs should be rounded slightly for greater comfort and to protect the seat.

The seat is made from either 8- or 10-oz. duck, cut into the form of a triangle 15 in. long each way and hemmed around the edge. A small patch of the same material should be sewed at each corner so that the fabric is doubled where the seat is fastened to the legs. The triangle is fastened in place with brass-headed furniture nails. Properly made, these seats will support a 200-lb. person without difficulty.

The legs for the table are made from the same size material, but are hinged to facilitate packing. The upper part of two of the legs is 20 in. long, while the third leg is cut 18 in. long so that it will fit properly into the boxlike hinge. The holes for the cotter-pin swivel are drilled 15 in. from the upper end of the short leg and 17 in. from the top of the two longer legs. It is then necessary to drill a 7/32-in. hole ¾ in. from the top of the short leg. The bottom part of each leg is 15 in. long. The leg sections are joined with 1-in. hinges so placed that when the legs are assembled, the hinges are downward.

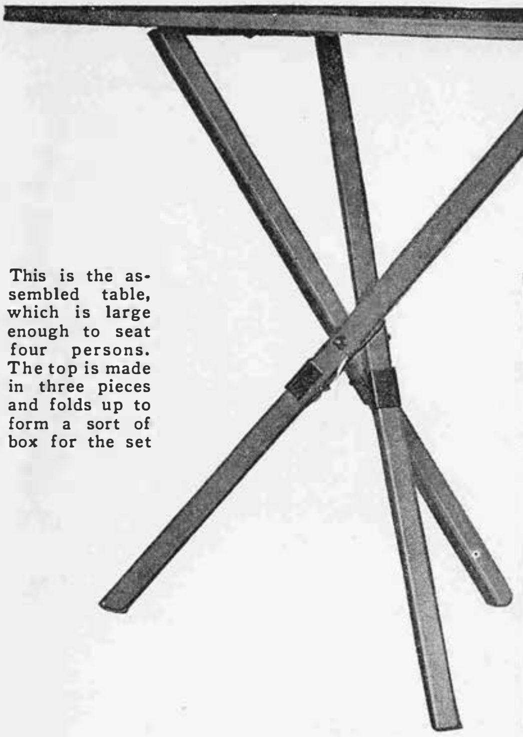
The legs are further stiffened with U-shaped channels made from 1/16-in. sheet iron, 2 in. long. Bend these channels by clamping the iron in a vise together with a hardwood or metal block of the same thickness as the legs. The sheet iron forms easily, and a workmanlike job will result if you use a block of wood instead of a hammer to force the metal around the form. You will need one channel section for each leg. Be sure that the chan-



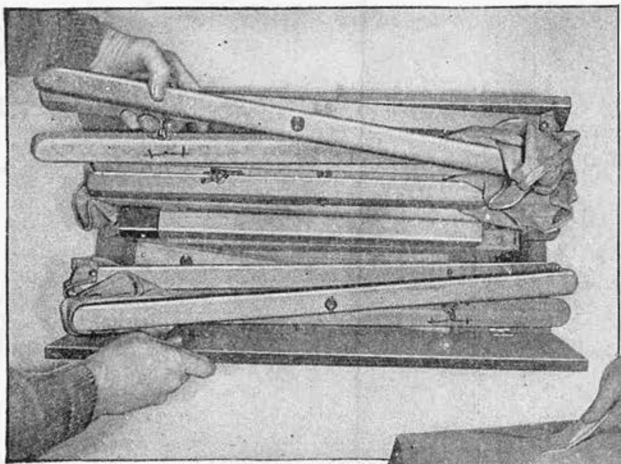


The swiveling joint for the legs is made from three split cotter pins 3/16 by 2 in., bent as shown at the right. The parts are assembled as above, washers being placed on each side of each leg

How to construct portable furniture for serving outdoor meals. . . . The complete set can be packed in a small bundle. . . . Materials are inexpensive



This is the assembled table, which is large enough to seat four persons. The top is made in three pieces and folds up to form a sort of box for the set



When the table is folded, the four seats are readily packed within it as illustrated at the left. All are then slipped into a canvas carrying case, which appears below. The complete outfit weighs about 9 lb.

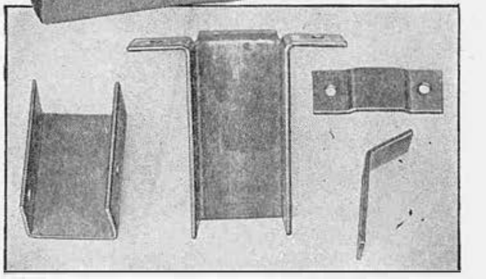
and CHAIRS

nels fit the legs snugly, and fasten them to the legs with wood screws.

The hinge for the short leg also is made from 1/16-in. metal, but is cut 5 in. long. After bending it to shape, make a saw cut in each corner for 1½ in. and bend these ends at right angles to the body of the hinge to form the support for fastening the hinge to the top of the table. A hinge of this design is necessary in order that the legs may be folded compactly for packing the outfit. This hinge is fastened to the top of the table by screwing it to the centerboard, 2 in. from one edge.

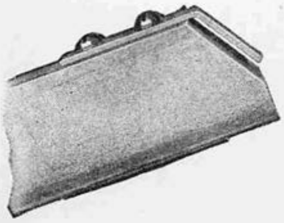
From the same gauge sheet metal, cut two pieces ¾ by 2 or 2¼ in. to form clips for fastening the remaining legs to the table top. These pieces are bent in the center to an angle, as illustrated, so that one face will fit against the underside of the table top when the legs are opened to their proper positions. The upper ends of the legs are, of course, first cut to this same angle, which will be about 40 deg. It will probably be more satisfactory to cut them to fit and thus compensate for any slight errors in dimensions. The metal angles are fastened to the legs so as to leave a gap of 3/32 in. to permit their entry into the sockets.

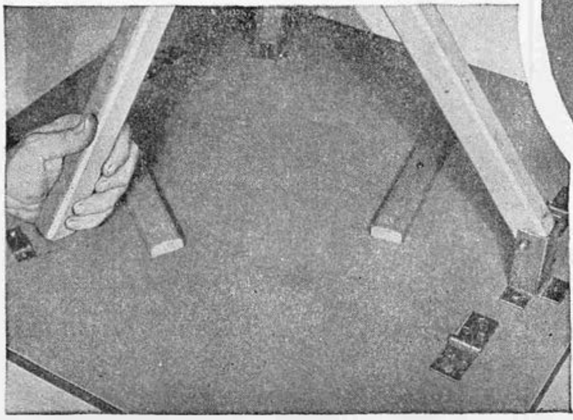
The sockets are formed from ¾ by 2½-in. sheet metal, bent over a piece of the same metal to form the shape shown. The exact location for the sockets is likewise best determined by trial, because if they are slightly out of square with the strips on the legs, the assembly will be

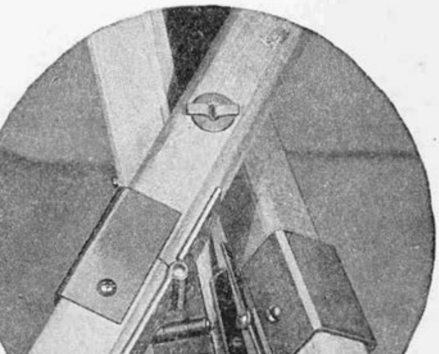


The various pieces of hardware required for the table are easily made from 1/16-in. sheet metal

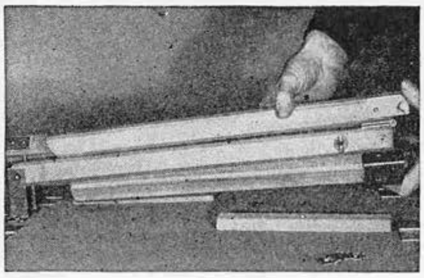
Two of the table legs have clips like that shown below. These are screwed on so that there is a space of 3/32 in. between the bent end of the clip and the top of the leg







The table legs are hinged on the underside just below the swivel joint and are reënforced with sheet metal that has been bent to a channel shape. How the legs are fastened to the table top is illustrated in the view at the left



One of the table legs has an elongated, box-like hinge so that all the legs may be folded

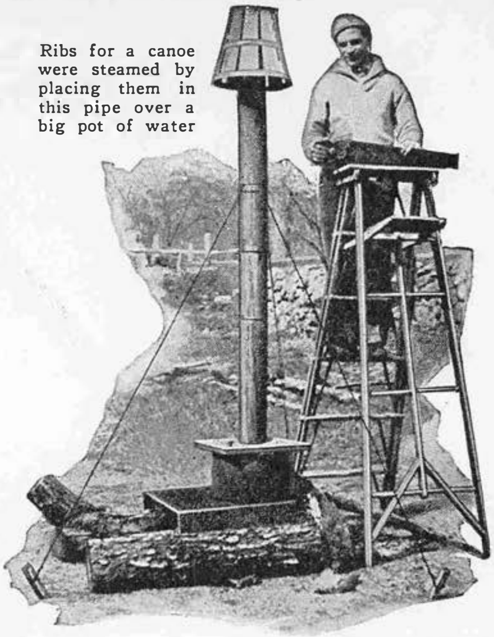
difficult or impossible. The bottom ends of the legs also should be beveled. If the furniture is to be used on a hard surface such as a floor, it is advisable to round the bottom ends of the legs of the seats as well as the table, but if they are to be used on soft turf, the flat ends will resist sinking into the soil better.

The top for the table is constructed from ½-in. wood, 8 in. wide and 24 in. long. Three pieces are necessary. The pieces are fastened with hinges, and two strips should be screwed to the central piece in such a manner that they can be swung over the cracks to stiffen the table.

For finishing the wooden parts, shellac or spar varnish will give a better surface than paint, as it will not become marked so quickly.

For packing, the three panels of the top are folded to form an open-sided box in which the four chairs can easily be stowed away. A canvas case, 8½ by 9 by 24 in., should be made to carry the outfit. The case or bag can be closed at the end with a patent fastener or by means of eight grommets through which a cord can be passed.

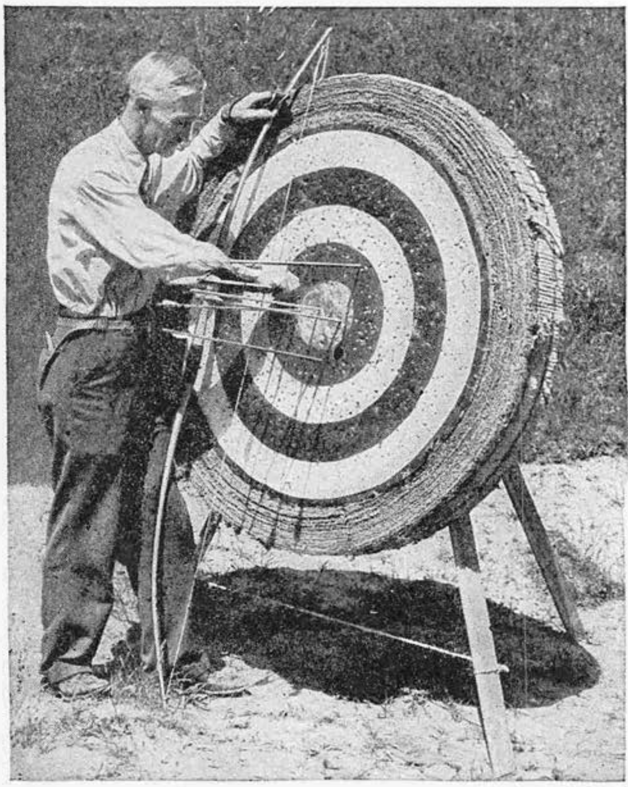
STOVEPIPES FORM STEAM BOX FOR BENDING RIBS

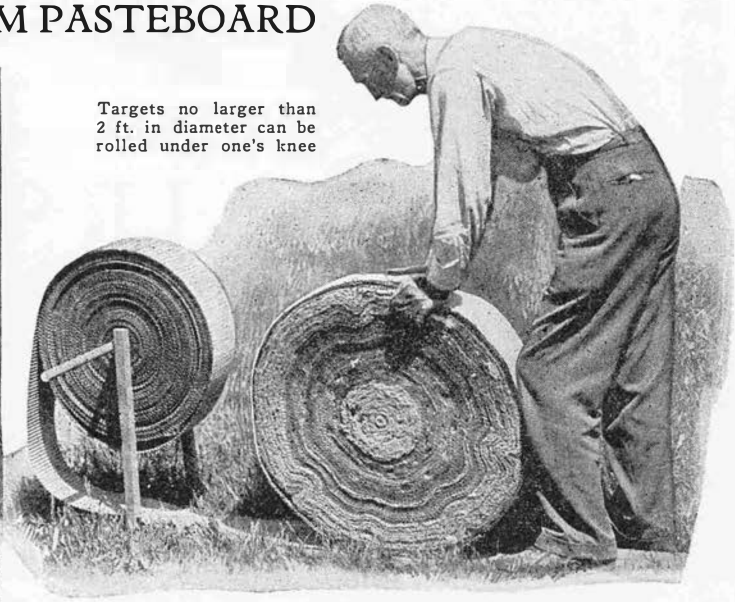


Ribs for a canoe were steamed by placing them in this pipe over a big pot of water

In the construction of a canvas sailing canoe, it is necessary to steam all the ribs. By mounting several lengths of stovepipe over a pot of water, a very simple and effective steam box is obtained. The ribs are inserted and removed from the top, and a basket is used to regulate the escaping steam. Three guy wires from the top hold the pipe upright. The source of heat is optional.

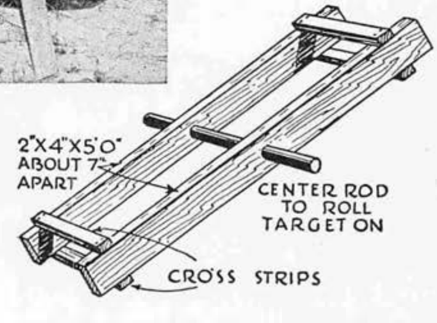
ARCHER ROLLS TARGETS FROM PASTEBOARD





Targets no larger than 2 ft. in diameter can be rolled under one's knee

Bigger targets like that at the left are started in the same way but finished on a wooden frame of the type shown below



STRAW target backs used for archery are expensive, wear out quickly, cannot be repaired when the centers have been shot away, and cannot easily be made at home even in the few localities where suitable rye straw is to be obtained. An excellent substitute, however, can be made from ordinary single-faced corrugated pasteboard, which is sold in large rolls for packing purposes. A target back of any size can be rolled from this material. The cost is low, it lasts well, and it can be repaired easily.

Saw the roll of corrugated board into 5- or 6-in. lengths and crush the strips as flat as possible by running them between the rollers of a wringer, by flattening them with a lawn roller, or in any other convenient way. If the target is to be no larger than 2 ft. in diameter, it is now necessary only to roll the strips as tightly as possible under your knee and bind with wire as described a little later on. It will improve the target to brush the pasteboard heavily with a solution of sodium silicate (water glass).

If a standard 4-ft. target is to be made, prepare a frame as shown in the drawing. Bore the center for a wood roller. It is best to start rolling the target under your knee (with the wooden roller in the center) until a diameter of about 18 in. has been reached and then mount it in the frame and continue rolling. Make the target from 4- to 6-in. oversize. As soon as the rolling is completed, place two No. 6 or 8 wires around the target as tight as possible and crimp them with pliers. Insert a small, hard roll of pasteboard in the center.

When the center has been hit so many times that it "leaks," loosen the wires, push out the damaged part, and roll and insert a new center. It may then be desirable to cut out a wedge-shaped segment from the old part of the target, starting at the new insert and widening out to about 4 in. at the outer edge. Apply new wires and tighten until this space closes.

ANY HUNTER CAN MAKE HIS OWN LIGHTWEIGHT

Silhouette Decoys

Cut from wood or sheet metal and painted, they successfully attract ducks, geese, crows, and snipe

Simple and inexpensive as they are to construct, good silhouette decoys lure many birds to a hunter's blind

DECOYS are an important part of the bird hunter's outfit. The silhouette type is light to carry and has proved very successful for hunting ducks and geese. More are being used now than ever because live decoys are prohibited. Silhouettes are also used almost exclusively in shooting crows, and recently snipe hunters are using them to lure these fast, zigzagging birds within gun range.

Any hunter can make his own silhouette decoys at low cost. First lay off a block of 1-in. squares on a sheet of cardboard and draw life-size patterns of the types you wish to make. The drawings, when enlarged as indicated by the squares, are slightly oversize because a large decoy draws better and is more easily seen by the game. Cut your patterns out and sand the edges to remove scissors marks. Use them as templates to mark the material.

Thin lumber or ⅜-in. plywood is suitable for ducks and geese, ¼-in. plyboard or sheet metal for crows, and sheet metal for snipe. If you have a band saw, you can cut out six or eight silhouettes at one operation. Lacking power tools, use a keyhole, coping, or compass saw for wood. Curved-blade tin snips or metal-cutting jig saws will serve for metal silhouettes. File all sharp edges away to prevent cutting your hands. Be sure to manufacture enough decoys of each species. Larger groups always draw more game.

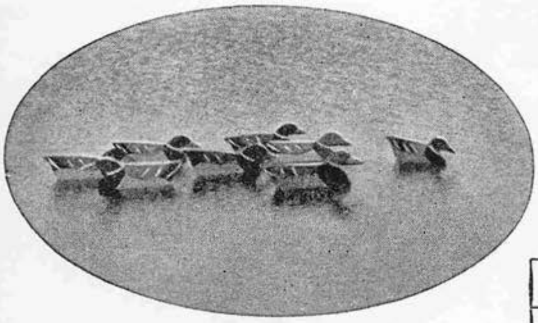
Sand the edges of the duck silhouettes smooth, and round off the edges around head and bill. Duck silhouettes can be provided with long wire or wooden legs, but the best plan is to use the float shown on the following page. Note how each silhouette is clamped in the sawed slot with a bolt and wing nut, and also how two floats are joined with a crosspiece and bolts so the decoys can be shifted backward or forward to change their relative positions. Wing nuts enable you to disassemble the float quickly for packing. Provide a cord and weight to anchor the float at the chosen location.

In setting out duck silhouettes, place them crosswise to the wind. Ducks usually decoy towards your blind into the wind and thus get a full-width view of the silhouette as they approach.

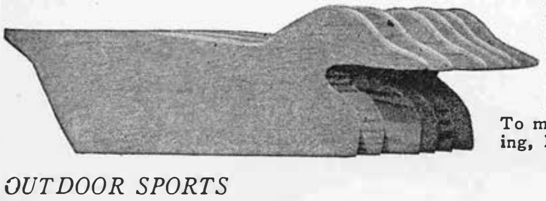
Don't let the coloring dismay you. It is not necessary to be an artist to paint silhouettes that draw game well. Many ducks have been shot over poorly colored decoys, and if you get the colors approximately right, the result will be good. Give all wooden decoys a preliminary coat of shellac to seal the wood.

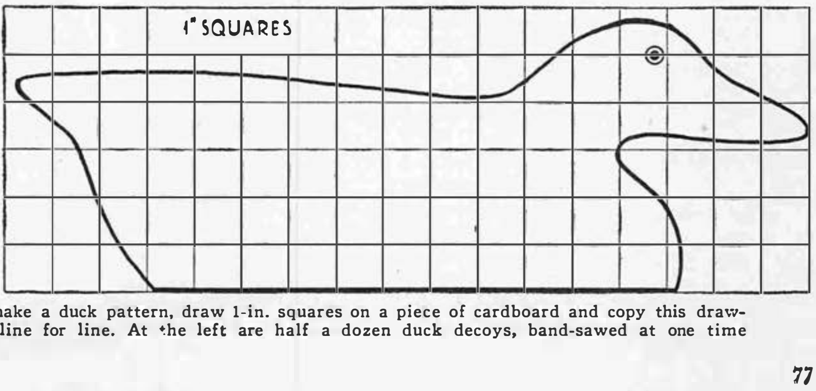
Mallard painting is popular with duck hunters because it will draw other species of ducks also. To paint twelve duck silhouettes, you will need 1 pint of white and ½ pint each of dark brown, black, colonial yellow, shutter green, bright blue, and silver gray. Use oil paint or quick-drying enamel, but if enamel is used it should be rubbed with pumice and water when dry to dull its shine slightly, otherwise the decoys may glare too much in the sun. You should have a No. 1 water-color brush for the eye rings, a No. 6 for stripes, and a ¾-in. varnish brush for the body colors.

Prime the ducks all over with one coat of white. Charts are given to indicate the colors and their locations for both the mallard drake and the hen. Paint the lower body of the drake a dove color, made by mixing some white and a very little brown with silver gray. Add a little black to the shutter green and paint the drake's head. Mix a little dark brown with silver gray to get the medium taupe of the duck's upper body and wing. Apply this medium taupe, let it dry five min-

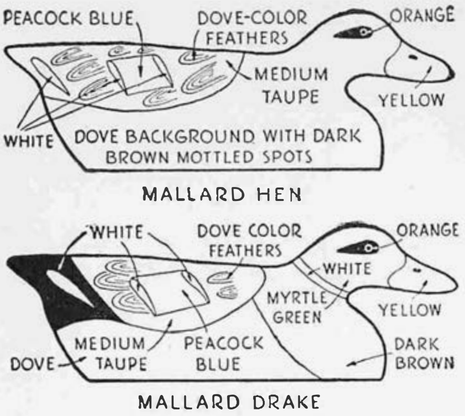


Mallard duck decoys of the silhouette type. They are popular because they will attract other species as well





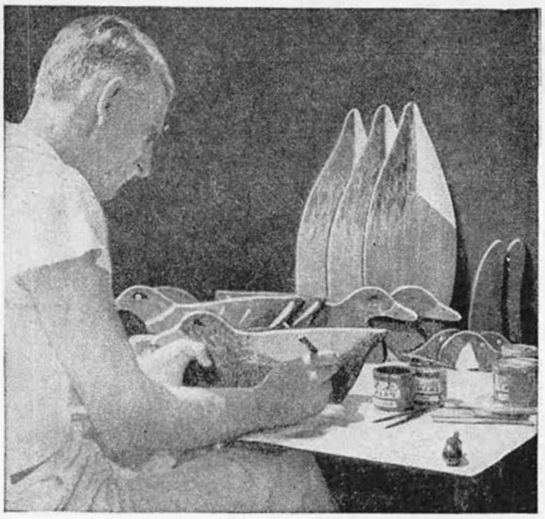
To make a duck pattern, draw 1-in. squares on a piece of cardboard and copy this drawing, line for line. At the left are half a dozen duck decoys, band-sawed at one time



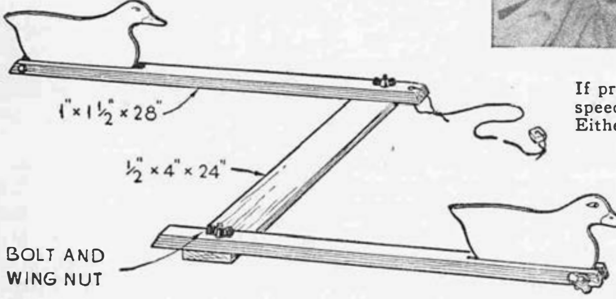
MALLARD HEN

MALLARD DRAKE

Color charts for painting mallard decoys. The feather markings are combed into the wet paint



If properly systematized, the painting can be done speedily, and no great artistic skill is required. Either oil paint or quick-drying enamel may be used



Collapsible float. The 24-in. connecting strip can be move away from, or closer to, the ends of the other pieces to make the decoys float properly

utes, then put in feather markings. A good idea is to use a piece of tin 1 in. wide and notched with six teeth. The teeth scrape away the wet taupe and expose the white priming underneath to produce the desired imitation of feathers.

A little green added to the Colonial yellow gives the right color for the drake's bill. Where black tail and taupe wing meet, apply the two colors and before they dry, sweep the brush back and forth, mixing the wet shades until they blend or shade off at the junction.

Add a little dark brown to the Colonial yellow to get the orange color for the drake and hen eye ring. Apply the black head and bill marks and the blue and white wing markings last. Put a drop of dark brown into a little of the light blue to make the latter more nearly the true peacock blue of the mallard wing. Add the white neck stripe and white tail dash. Remember when mixing paint that it will probably dry dark, so mix somewhat lighter than you wish the finished work. Your most common mistake will be in getting the body colors too dark.

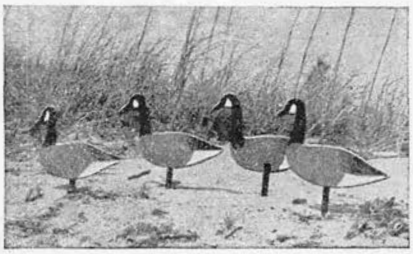
In coloring the mallard hen, paint the entire body the dove hue, then splotch it with dark brown. To make this mottled effect, put some dark brown paint on a board, take a very little of it on the end of a brush, and stamp the brush down on the dove background. Don't dip the brush in the paint can for this work. Paint the hen's bill colonial yellow which has been tinted with a small amount of dark brown.

Goose silhouettes are sawed from plywood after separate patterns have been made for the body, neck, and head. The leg is plyboard, 1 in. wide by 13 long. Assemble with rivets. The silhouette then can be folded compactly for carrying and when set up, the heads and necks can be given slightly different positions to make the group more lifelike, as illustrated in a photograph on this page.

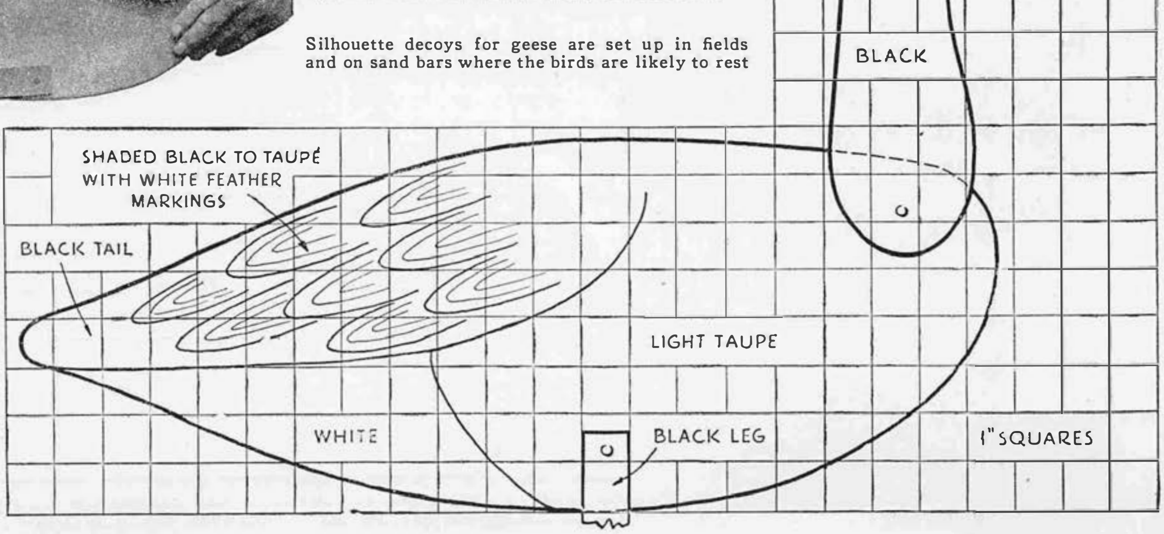
For eight goose silhouettes you will need 1 pint white and ½ pint each dark brown, silver gray, and black. Prime the goose decoy with white, then paint the white lower rear body. Use a light taupe for the upper front body, obtained by mixing a little dark brown with the silver gray. Then paint the goose tail black for 2 in. and blend immediately into the taupe by brushing back and forth across the two wet colors. Apply realistic feather marks as shown.

Set goose silhouettes in fields and on sand bars where the birds stop to rest and feed. The best blind is a pit dug shoulder deep in the group and skillfully covered with some natural material. Goose hunters sometimes wear white suits like those used by surgeons in order to be less conspicuous when the ground is covered with snow.

Crow shooting is popular both as a move in conservation to preserve the eggs and young of game and song birds and also as a keen sport that tests the hunter's



Silhouette decoys for geese are set up in fields and on sand bars where the birds are likely to rest

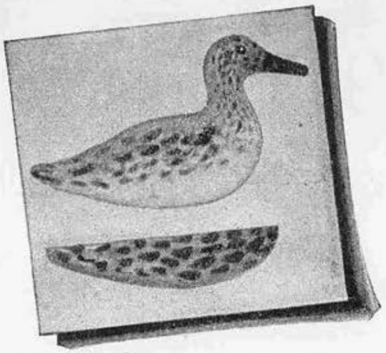

BLACK
EYE-BLACK CENTER, TAUPE RING
WHITE
BLACK
SHADED BLACK TO TAUPE WITH WHITE FEATHER MARKINGS
BLACK TAIL
LIGHT TAUPE
WHITE
BLACK LEG
1" SQUARES

Pattern and color scheme for goose decoys. The head, neck, and body are riveted in such a manner that the silhouette may be folded compactly for carrying, as shown in the photo above. This also enables the heads and necks to be set at different angles to make a group lifelike skill and improves his marksmanship for other game.

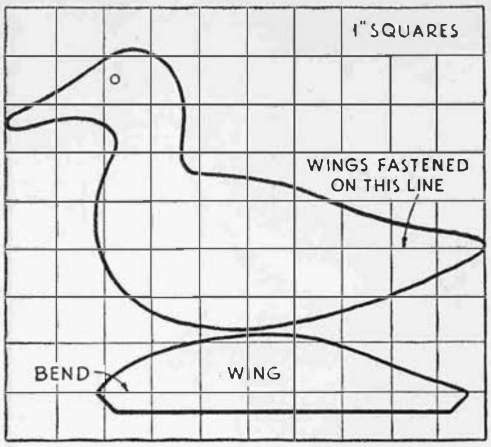
Effective crow silhouettes can be cut either from ¼-in. plyboard or metal. In either case make the wings from metal and tack or rivet them on each side of body. Drill a ⅛-in. hole clear through the material to serve as an eye. Apply two coats of dead-black paint to both sides of the decoy. Use wooden legs 7 in. long; these are shoved into the ground until the decoy is 2½ in. above the surface as shown in the photograph at the right below.

Use blinds of brush, cornstalks, or any natural material found where you shoot. Do not place crow decoys in timber. Locate them out in a field and build the blinds in brush-grown fence rows. When two men hunt together, make two blinds 35 yd. apart and place decoys at a point 30 yd. from each blind, the three locations forming a triangle.

Cut snipe silhouettes from sheet metal. Rivet on the wings, drill a ⅛-in. hole for the eye, and make the legs 13 in. long to hold the decoy firmly when set in mud. Paint the entire silhouette an oyster white made by mixing a little black and white; and before this dries, put on the soft mottled spots of very dark gray (silver gray tinted with black) and blend the edges of the spots carefully with a small water-color brush. The snipe's bill is black.

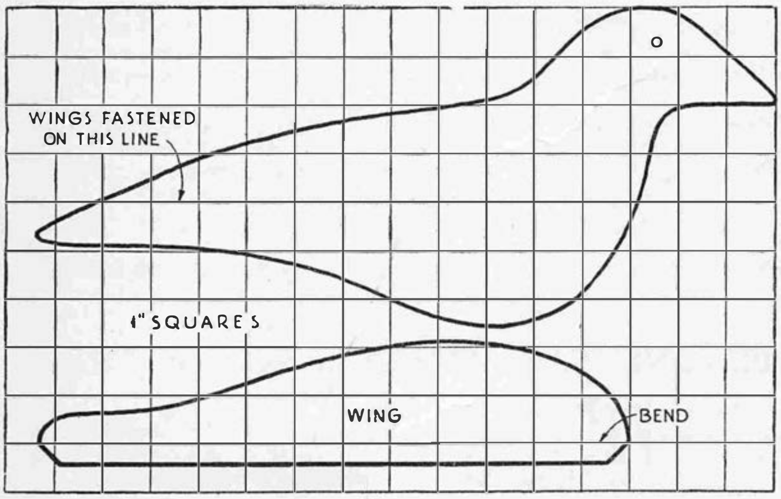


Snipe decoys are painted oyster white; then, before the color dries, mottled spots of very dark gray are blended in



Patterns for the snipe's body and wings. These parts are cut from sheet metal, and the wings are bent and riveted to the body on the line indicated. The eye is represented by a drilled hole. A leg 13 in. long is added to hold the decoy firmly when set in the mud

Snipe decoys in place. Set them on the bank or in shallow water at the edge of a marsh, lake, or ditch


WINGS FASTENED ON THIS LINE
1" SQUARES
WING
BEND

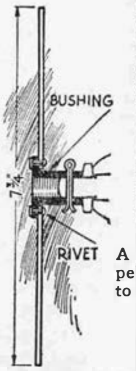
Crow silhouettes may be cut from either plywood or metal. They should be placed out in a field, and the shooting done from blinds in brush-grown fence rows. ***At left:*** The patterns

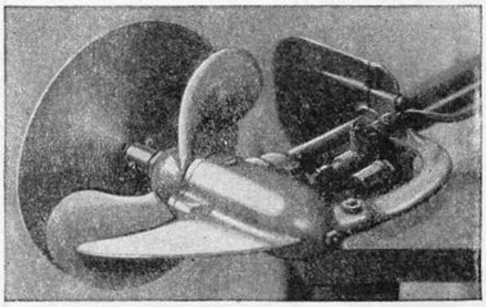
Disk Slows Motorboat *for* Trolling

BY ATTACHING a circular metal plate to an outboard motor as shown, it is possible to troll at speeds of from ½ to 2 M.P.H. The propeller turns as fast as usual, but the plate immediately behind the propellor greatly reduces boat speed. Cooling is not impaired. Any light twin, or even the larger motors, may be equipped in this way. It take only a couple of minutes to attach or remove the device.

The plate is 1/16 in. thick by 7¾ in. in diameter. Aluminum, sheet iron, or brass, purchasable at any junk yard, is satisfactory. The flange is a model-T Ford spindle body bushing, which costs about ten cents.

As outboard motor propeller shafts vary in diameter, the bushing must be drilled and tapped to fit. Some shafts may be smaller than the bushing hole, in which case it may be necessary to weld the bushing shut and redrill and tap it to the required size. The plate is then drilled to receive the bushing, and four 3/32-in. diameter holes are drilled in the flange and plate for rivets. Nails cut to size will serve as rivets. To prevent the plate from vibrating loose from the shaft, drill a 3/32-in. hole through the bushing and insert a cotter pin.





A circular metal plate, attached to the propeller shaft as shown in the drawing, serves to reduce the speed of an outboard motorboat

Fishing Waders

MADE FROM MUSLIN AT LOW COST

Durable home-made waders waterproofed with coats of rubber cement

FISHING waders can be made at a fraction of the price asked for them in sporting goods stores. Obtain about 3 yd. of heavy unbleached muslin of fine weave. The thread count should be 80 by 80 per square inch. Next get a piece of light wrapping paper about 26 by 60 in., fold it lengthwise through the center, and sketch one side of the pattern. When cut along the line with shears, both sides of the pattern will be uniform. The pattern illustrated is for a person of average height, from 160 to 180 lb. If the waders are to be for a short, heavy person, make the pattern shorter and broader. If for a tall, thin person, change it to suit.

Fold the material lengthwise along the center (or wide enough to fit the pattern). Cut two pieces like the pattern, and from the trimmings, cut four pieces for the feet.

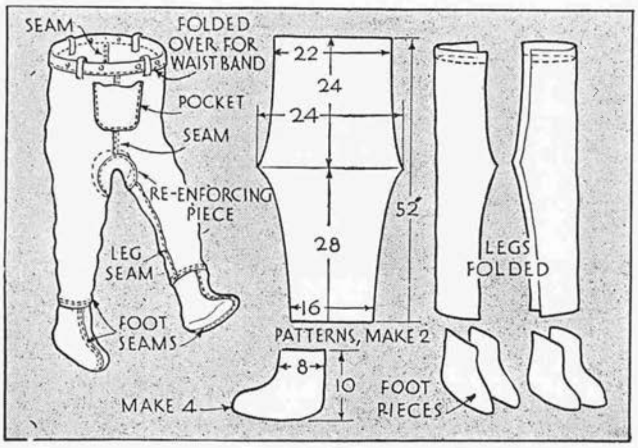
Sew the foot pieces together in pairs. Lap the edge of one cloth over the edge of the other about ½ in., and sew with a double or triple stitch all around, except at the top. Now lap and sew one of the leg pieces in the same way. Start at the bottom and sew up only 8 or 10 in., no more, otherwise there will be difficulty sewing on the feet.

Slip the foot piece over the bottom of the leg (or inside the leg) about ¾ in. As there is only one leg seam, which will be at the inside of the leg when the waders are worn, be sure to sew the foot in correctly. Have the leg seam come midway between the front and back seams of the foot.

Triple-stitch the foot to the leg; then finish sewing the leg up to the point of the crotch. Sew the other foot and leg similarly. Be sure the feet will both point the same way when the legs are sewn together from the crotch up, which will form the waist.

When the two parts are sewn, fold the top edge down about 2 in. and double-stitch to form a waistband for buttons. If you want belt loops, put them on now.

Cut a piece of the same material 9 by 12 in. and double-stitch it to the front of the waders about 1 in. from the top edge. Sew this at the bottom and both sides, also at the top about 2 in. in from the sides. This forms a roomy pocket for carrying lures, baits, "skeeter dope," and the like.



How to lay out waders for a man of average height and weight

Your waders are now ready for waterproofing. You may put on several coats of the regular commercial waterproofing sold for use on tents. This undoubtedly will serve the purpose satisfactorily, but rubber cement is much preferable. With a stiff paintbrush, apply several coats of rubber cement such as is used for tire repairing. Work the rubber cement in thoroughly. Let each coat dry before applying the next coat, which, depending upon the temperature, may take one to three days. Spread the cement over all seams generously.

Be sure to apply plenty of waterproofing on the feet, as that will be the only place where you may have trouble with leaks. It is also a good idea to double-stitch a small round reenforcing patch over the crotch where all seams join. This should be put on before waterproofing.

A suit of heavy underwear is about all that is necessary inside the waders. Wear a pair of thin socks, and over the outside of the wader feet put on a pair of thick coarse wool socks. To keep the socks from rolling down, tie them with a cord or use a rubber band cut from an inner tube. Over these wear hobnailed leather shoes, or a pair of rubber-bottom canvas shoes, such as are used for atheltics.

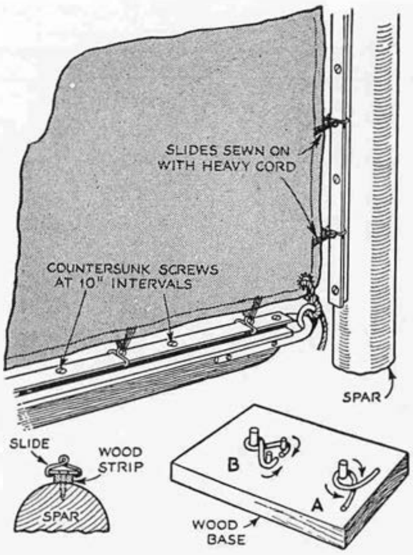
Sew on suspender buttons after waterproofing, and shorten a pair of old suspenders to fit. A belt may be worn in the loops as a measure of safety if found necessary—that is, in case one falls or gets in too deep.

INEXPENSIVE SAIL SLIDES AND TRACK

IN AN effort to build a sailboat at low cost, hardware is a considerable item. This design of track and sail slides can be built at a total cost of less than a dollar for a 16-ft. Marconi-rigged boat. The track is inexpensive flat iron, drilled and countersunk at 10-in. intervals for wood screws, and screw to the spar with a narrow strip of wood under it as shown. Care must be taken that all screws are countersunk, and that the wood strip is in the center of the track. The iron is given two coats of good varnish to prevent rusting.

The slides are bent from ⅛-in. brass rod in a jig made by driving spikes in a wood block. The rod is first bent around *A,* then the loop placed on *B,* and the ends were bent to form the slide. The finished slide must be a loose fit on the track and must also clear the wood strip.

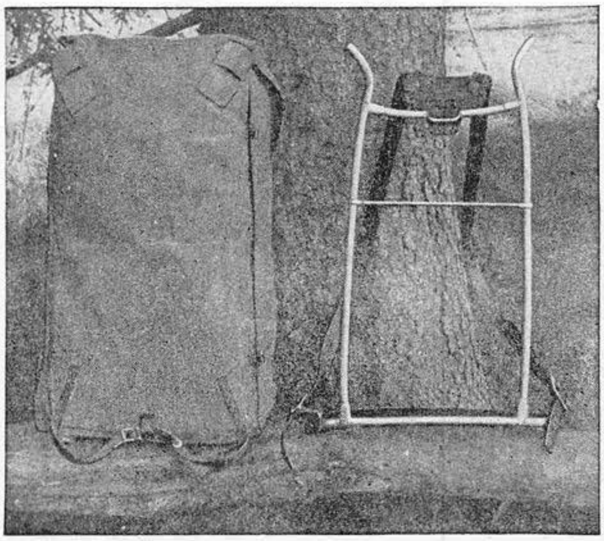
This design may be carried out with various materials, such as brass strips, galvanized iron, or black iron for the track, and the slides may even be made from common galvanized iron wire. Of course, brass is best.


SLIDES SEWN ON WITH HEAVY CORD
COUNTERSUNK SCREWS AT 10" INTERVALS
SPAR
SLIDE
WOOD STRIP
SPAR
B
A
WOOD BASE
ASSEMBLY
JIG FOR BENDING SLIDES

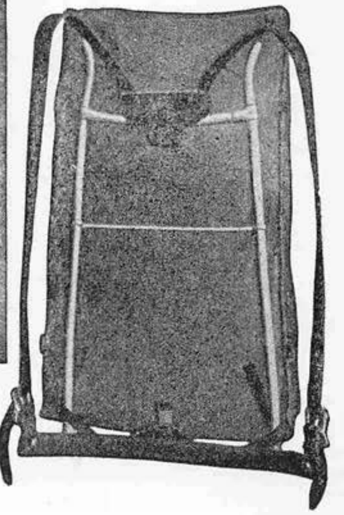
Slides are formed by bending thin brass rods around jig. The track is made from flat iron

Lightweight BACK PACK

Tailored to Fit Your Body



The joining faces of sack and frame and, at left, how the sack is worn. The shoulders have perfect freedom to move



Assembled pack, showing triangular pad that rests between the shoulder blades

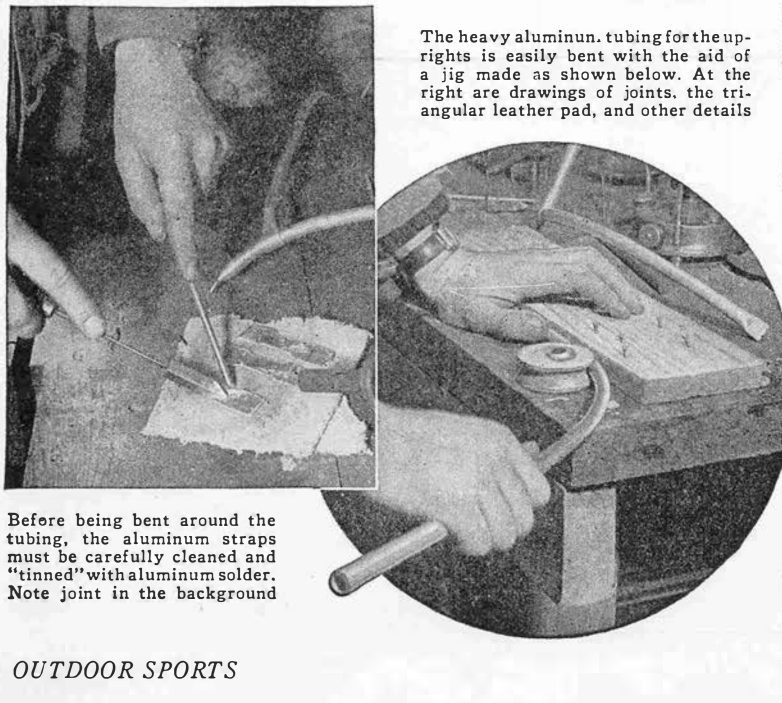
THIS mountain pack has been specially designed to carry the outfit of a camper, hunter, or hiker who prefers to travel light. The expense for materials is about $2.50, and the finished pack is more comfortable, convenient, and better looking than some commercial types costing from $15 to $20. That is because it is actually tailored to fit the body. Weighing only 5 oz. more than a common canvas pack sack, it distributes the burden on the back and hips so scientifically that the fatigue of hiking, even over winding mountain trails, is greatly lessened; and, of course, it is equally valuable for trips through level country.

The ordinary pack has many disadvantages. The straps, which are often of webbing, invariably curl up when wet and saw ridges into the shoulders. Many straps are too wide, and the edges cut into the skin while the tender tissues under the armpits are often tightly compressed. The pack usually fits too snugly against the back and is correspondingly uncomfortable. These and other disadvantages are all eliminated when man's anatomy is studied and the pack correctly designed. The frame to be described distributes the load and keeps the pack from rubbing against the back.

The framework may be made of any light but strong metal tubing that will not rust or corrode. The lightest is aluminum of the dimensions given in the list of materials at the end of the article. If larger tubing is used, much additional strength is obtained at the expense of an extra ounce or two. The metal straps at the joints may be cut from thin sheet aluminum or from an old or inexpensive aluminum utensil.

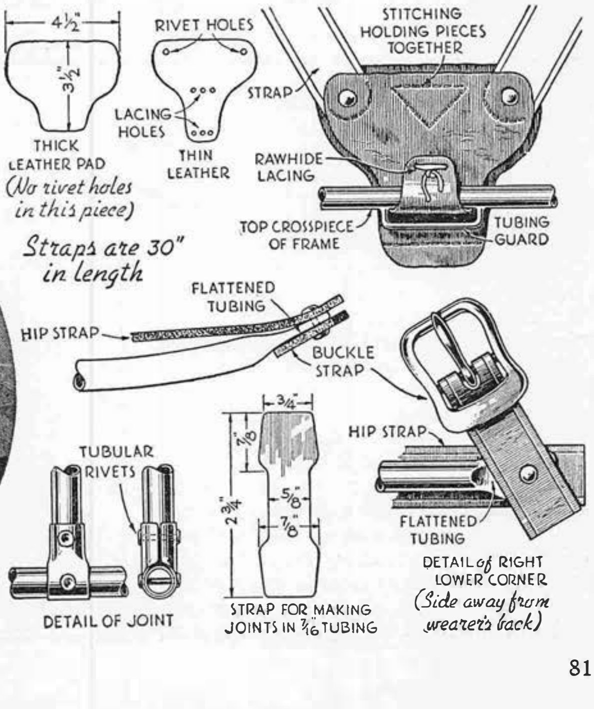
All the leather used should be made soft and pliable by soaking in neat's-foot oil. The cloth may be obtained from an outing supply house. The best shade for this purpose is dark green. The sewing can be easily done on a sewing machine if a heavy needle and about No. 12 cotton thread are used.

In constructing the frame, first bend the tubing as shown to fit the back. The best length for the uprights is the distance from the lower tip of the ear to the belt line—about 22 in. in a person 5 ft. 10 in.



The heavy aluminun. tubing for the uprights is easily bent with the aid of a jig made as shown below. At the right are drawings of joints, the triangular leather pad, and other details

Before being bent around the tubing, the aluminum straps must be carefully cleaned and "tinned" with aluminum solder. Note joint in the background



At the back is a full-length pocket with a slide fastener. Around the sides and bottom are leather tabs for tying on extra articles

tall. The top of each upright is filled with a tight plug of wood having a round top, because the whole weight of the sack is on these tips when in use.

The bottom crosspiece is cut the exact width of the wearer's hips and bent in a gentle curve so that when the two ends are held against the hips, the center of the arc is about 2 in. from the spine. The upper crosspiece is cut about 6 in. shorter and bent so that the center is placed about 1 in. nearer the wearer's back than the two ends. Unlike the lower piece, the convex side of this curved piece is to be placed next to the wearer. This curvature prevents the frame from interfering with the action of the shoulder blades as does an ordinary pack.

On the bottom side of the upper crosspiece, a U-shaped piece of the smaller tubing is fastened by inserting its ends into holes drilled in the larger tubing, and secured by soldering. This tubing keeps the leather back pad from sliding sideways on the frame.

Four flat straps of aluminum are cut to the pattern given, and the four pieces of tubing are then joined as shown. First the flat pieces and all surfaces to be joined must be "tinned" with aluminum solder. Much more heat is required to melt this solder than the ordinary type.

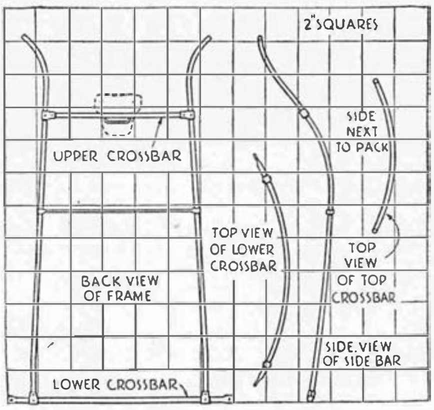
After the joints have been soldered, holes are drilled and, instead of rivets, short pieces of the smaller tubing are inserted and upset on both ends to form heads, giving additional strength to the joints. An extra crosspiece of the smaller tubing is placed at the point of greatest curvature of the frame to aid in keeping the pack away from the wearer's back.

Next, the leather straps are attached. Make the hip strap long enough so that it may be tightened or loosened by a thong threaded through four holes punched in the center.

The adjustment of the frame to the back is quite important. It must have enough curve so that it will not hit the back at any point except on the hips and at the shoulders on the main pad. There is an area between the shoulder blades just below the last projecting vertebral spine of the neck which is quite insensitive and bears loads well. It is worth one's while to find this spot and place the pad over it. The tips of the bottom crosspiece should be lower than the rest of the frame, so that the hip strap will have the proper downward bearing on the hips. Remember that the hip strap carries a good part of the load and does not merely keep the pack away from the back.

When properly bent to shape, the frame does not touch the back unless the wearer bends far forward; this allows him to bend and twist on a mountain trail without having the frame touch him. The upper crosspiece is not fastened tightly to the pad, but rather is so attached that it rolls on the pad. This gives a three-point suspension to the frame and allows the wearer to move his shoulders with great freedom.

After the frame has been adjusted, the sack must be made. In shape it conforms roughly to the frame, and the sides are cut to fit its sidepieces. This is necessary to make the load rest correctly on the frame without tending to straighten it out.



How the frame members are bent and joined

The one large pocket is sewed up first with an 8-in. opening placed vertically in the middle. Extra tabs of several thicknesses of cloth are placed at each end of the opening to aid in pulling the slide fastener as well as to reenforce the opening. Tabs of leather are sewed to the pocket and back of the sack to aid in tying down the cover of the sack.

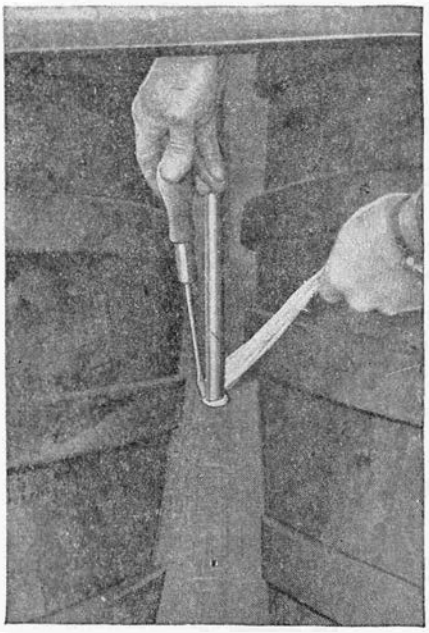
When all the pieces have been cut to the proper size, the sack is sewn together. It is best to sew it once on the inside and then turn it right side out and sew it again. On the front of the sack (the side next to the frame) webbing or leather pockets are sewn to fit the top of the frame. These are lined with sheet aluminum. A simple arrangement of straps at the bottom serves to tie the sack to the frame. This is shown in one of the illustrations and in the sketches.

In all the seams of the sides and the bottom, extra loops of leather are sewn to enable extra articles to be lashed to the sack if necessary. More pockets may be added if desired. The top of the sack is closed by means of a leather thong, which runs through No. 1 brass grommets set around the edge. The top is made in a semiboxed style so that one fastening string will be enough.

List of Materials

6 ft. 7/16-in. O.D. (outside diameter) aluminum tubing with 1/32-in. wall.
2 ft. 3/16-in. O.D. aluminum tubing with 1/32-in. wall.
1 stick aluminum solder.
1 pair leather suitcase straps, 36 in. long.
2 yd. waterproof tent cloth, 27 in. wide.
1 doz. No. 1 brass grommets.
1 pc. 3/32-in. thick grain leather, 8 by 8 in., and 1 pc. 3/16-in. thick sole leather, 5 by 5 in., or miscellaneous bits of leather.
1 slide fastener 8 in. long.
Copper rivets.
Black cotton thread (No. 12) and suitable sewing-machine needle.

CLOTH STRIP CHECKS STUFFING-BOX LEAK



To make an emergency stuffing box, a narrow strip of well-greased cloth is pressed into the hole in the sternpost

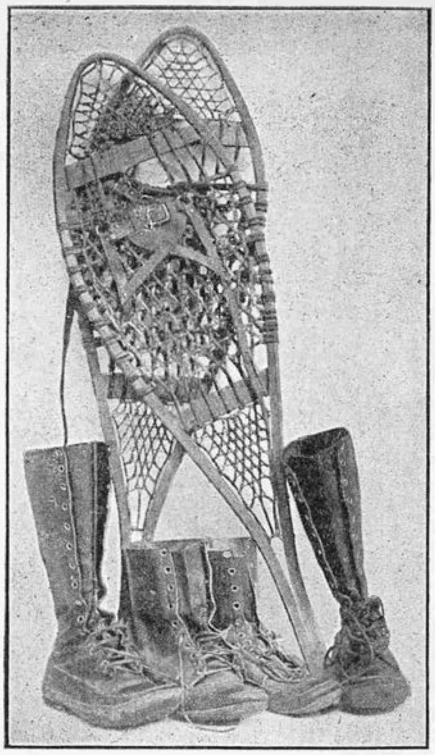
WHEN an outside stuffing box on a small motor boat becomes loose enough to leak badly and cannot be repaired immediately, as will sometimes happen during a trip or in the midst of a busy season, a temporary inside stuffing box can easily be made by winding a long, narrow strip of cloth around the shaft and pressing it tightly into the hole in the sternpost with a screw driver, as shown at the right. Before this is done, however, the cloth must be thoroughly greased by pulling it several times through a handful of grease.

While this expedient is not intended as a permanent repair, a temporary stuffing made in this way will stop the leak completely, and will partially relieve the outside box of any strain that would make the leak worse.

SCREW THREADS IMPROVE BEACH UMBRELLA

IT OFTEN takes considerable strength to push the end of a beach umbrella far enough into the sand to make it hold firmly, especially in a strong breeze. To make the pointed end enter the sand more readily, simply cut a coarse screw thread on the end—something like a gigantic wood screw. This is easily done by holding the pole at an angle against the blade of a circular saw. The stick can then be turned into the sand with little effort. The same expedient can be used when it is necessary to drive other long wooden poles into the sand or earth.

MAKE YOUR OWN Snowshoes



A pair of good general-purpose snnwshoes with a harness, pacs, and moccasin-type waterproof boots for use in light snow

MOST of the Canadian Indians and many white trappers make their own snowshoes. Sometimes the handmade article is not so handsome as the store variety, but it is often much stronger and more durable. Making snowshoes is good fun, and by following the directions given in this article, you can make yourself a serviceable pair of shoes that will stand up under the hardest use on the trail.

For making the frames, the best woods found in the North are hickory, ash, and white and yellow birch. White birch is most generally used. Select a slender tree about six inches in diameter, free of knots and twists for a length of ten feet. Drooping limbs indicate strong wood. Fell the tree and cut out a section about ten feet long, or twice the length of the snowshoes.

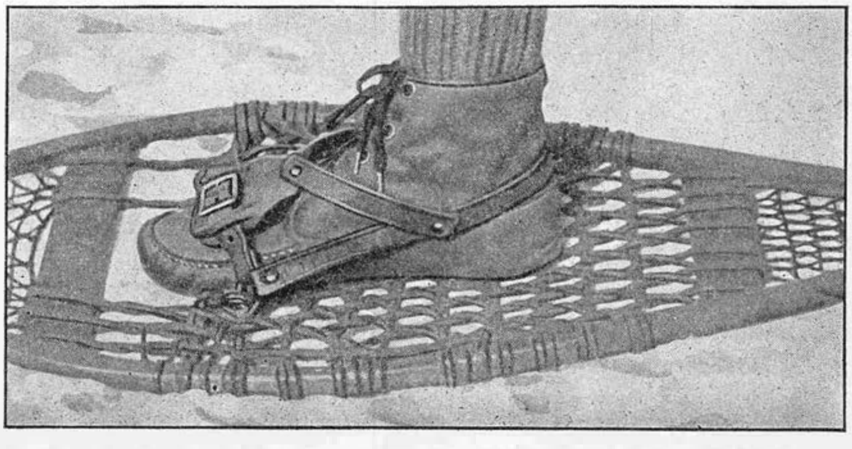
This secion should be split and the better half quartered. To insure a good job of splitting, the log should be grooved its entire length, about one inch deep, top and bottom. Start the split by striking lightly with the ax in the bottom of the groove; finish by using wedges, taking care to make the split follow the groove. Take the better of the two pieces, cut a groove the length of the bark side, and split it. This will furnish the two pieces for the snowshoe frames. The bark side is used for the outside of the frames, and no cut should be made in the wood on this side.

For taking the wood down, you should have a hand saw, a plane, and a drawing knife. The extent to which the stick should be worked down will depend on the size of the proposed snowshoe, which is governed in turn by the weight of the user, and the loads he may carry. For a person weighing under 150 pounds, an elongated snowshoe measuring twelve inches wide, inside the frames, and forty-two inches long, will be about right. The tail will be about ten inches long. The frame for a snowshoe this size should be five eighths of an inch thick, and the width should vary from three eighths of an inch at the toe, or center of the stick, to three quarters of an inch at the tail ends. Remember to pare the wood down on the inside of the bend, opposite the bark side. Bear in mind that the stick must be about eight feet long to make a forty-two-inch snowshoe. A heavy man will require a fourteen-by-forty-eight shoe, necessitating a ten-foot stick.

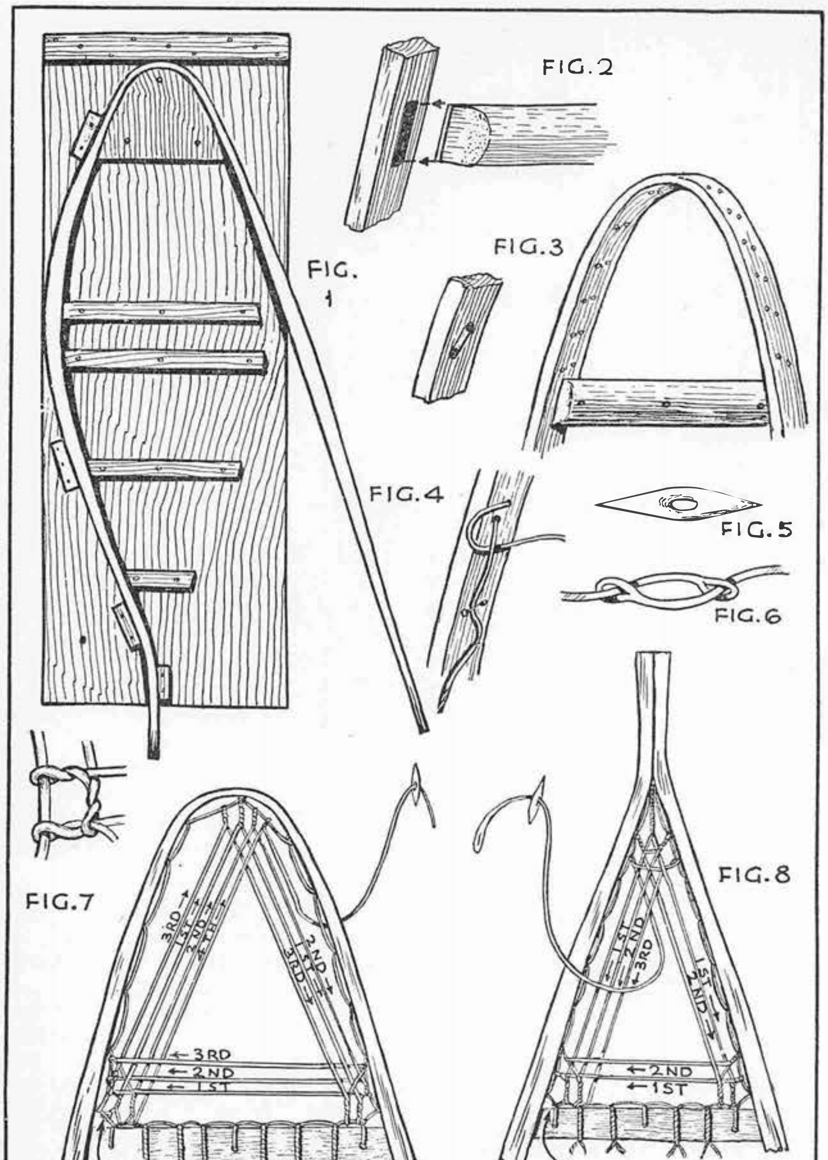
Measure off about seven inches each way from the center of the stick, and start a mortise on the inside of the stick (Fig. 2) for the first crosspiece, which will be a quarter of an inch thick, one and three quarters inches wide, and from eight and three quarters to ten inches long, allowing for bend in the frame. About sixteen inches farther back toward each end of the stick, mortise for another crosspiece, which will be approximately six and one half inches long. These mortises should not be deeper than one quarter of an inch.

The next step is to make a form for bending the frame, as shown in Fig. 1. Bending will be easier if the stick has been soaked in water a few days. To make the U-bend, lay the stick across a kettle of boiling water and mop it with the steaming water. A bunch of rags tied on the end of a stick will do for a mop. The center of the stick must be given the most attention. After the wood has softened, bend slightly, then repeat the mopping and keep on until the wood will bend into the shape desired without cracking. Small splinters can be cut and sanded off. The stick is held on the board by cleats nailed in place. A form will be required for each snowshoe. The frames should dry in a week or ten days.

The two crosspieces for each shoe should be made in time to dry thoroughly by the time the frames are set, and are then mortised in tightly. They



A practical snowshoe foot harness like this is obtainable anywhere in the Northland



FOLLOW THESE DIAGRAMS IN MAKING SNOWSHOES

This drawing shows the successive steps in the making of a pair of snowshoes. 1, the form for shaping the frame. 2, mortise for a crossbar. 3, holes drilled in toe of the frame for lanyard. 4, how the lanyard is strung. 5, needle for weaving thongs. 6, the method of splicing. 7, filling the toe. 8, filling the heel. 9, how the center is filled. 10, how center thongs are looped around the frame. 11, reinforcing the toe hole

Full Directions for Making a Pair of Sturdy and Dependable Snowshoes That Will Carry You Over the Deep Snows of the Woods

will be about sixteen inches apart and the snowshoe must be heavier at the tail end when balanced midway between them.

The tail end of the shoe may be riveted together, or bolted with very light bolts, countersinking the head and nut. However, the woodsman's method is to drill holes and tie the tail together with rawhide thongs, countersunk to prevent wearing.

With the frames finished, you are ready for the rawhide filling. Light cowhide is generally used for the center filling, and calfskin or some other light leather for the ends. Seine twine is often used here, but some prefer light rawhide.

The cowhide should be grained (have the hair taken off) while green. This is done by putting the skin over a smooth beam and scraping the hair with some tool sharp enough to remove the hair and scarfskin, but not too sharp. After the skin has thoroughly dried, it should be dampened and the edges trimmed off before the strands are cut. Sharp shears or a small knife will be needed. The thongs should be cut rather wide, particularly in thin places, to allow for shrinking. The strands should be cut around the hide in lengths eight to twelve feet long, leaving the ends a little wider to permit splicing. After the strands are cut, they should be soaked, stretched, and resoaked.

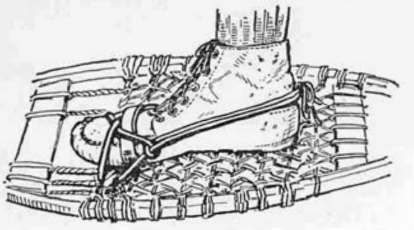
The toe of the shoe is drilled (Fig. 3) for the lanyard, which is strung tightly as shown in Fig. 4, and allowed to dry before the filling is put in. Fig. 5 shows a needle for putting in the filling. This device should be about two inches long and preferably made of bone, although hard wood will do. Fig. 6 shows how splicing is done. Splices should not be made on the frames or under the foot.

In doing the filling, the strands must be kept moist and soft. It is a good idea to work over a pail of water, and fill the toes first.

The drawings leave little more to be said about the method of filling. Different craftsmen use different systems. Perhaps the novice will have better success by borrowing a snowshoe and tracing its filling as a guide. In the toe, every other round loops back around the preceding one, as indictated in the small illustration, Fig. 7. When filling has reached the entire width of the end of the toe, the looping-back is discontinued and the toe is finished.

The filling of the heel is shown in Fig. 8. In filling all sections, the twists, loops and meshes must be exactly right, and if you make a mistake, go back and correct it. A hardwood pick will be useful for straightening out meshes. When a section is started, it must be finished before you stop.

The center (Fig. 9) is filled in the same manner as the toe, except that the strands are looped over the frame (Fig. 10) instead of a lanyard. And, of course, heavier thongs are used. The heaviest strands should be used for the toe cord, crossing the shoe four times for a twelve-inch shoe



Simple fastening of string used by woodsmen. It is easily untied, even with numb fingers

and six times for a fourteen-inch shoe. This toe cord will be started about four inches back of the front cross bar. There should be no sharp edges on the frame to cut the strands.

A TOE hole about four and one half inches wide must be left in the center of the toe cord. At this point the filling is no longer looped around the front cross bar, but is woven through the toe cord. Knots and rough places must be avoided on this toe cord where the foot rests. The filling will end in the center of the toe cord, and should be woven in and out several times to make a secure fastening.

Fig. 11 shows how the toe hole is reinforced. A strand of rawhide is looped around the front cross bar, passed down to the toe cord, around this cord several times, back to and across the cross bar, then spiraled around the bunch of strands all the way back to the cross bar.

After the filling is completed, the shoe should be put away to dry slowly, never in the sunshine or by artificial heat.

Comfortable snowshoeing requires proper foot wear and fastenings. The fastening, which is the connecting link between the foot and the snowshoe, is very important. If too tight, it will bind the foot and cause the toes to freeze. If too loose, the foot will slide through and the toes will contact the forward crosspiece.

There are a number of leather harnesses on the market, varying little in design. In general, they are quite satisfactory. The one in the photograph can be made by any cobbler or leather worker. The materials for a pair consist of about four feet of one-inch leather strap, four buckles, four metal rings, and one or two dozen rivets, which is all that is needed to make them.

A triangular piece of leather covers the ball of the foot, the wide end fitting over the toes. Slots are cut for the toe strap to go through and a buckle in the center of this strap permits adjustments for stretching or weather conditions. The strap is adjusted to hold the ball of the foot securely over the toe-hold filling, without binding. The rings in each end of the toe strap are tied securely to the snowshoe filling with rawhide thongs. From these rings an adjustable strap extends around the heel, on each side of the foot. Connecting straps are riveted to the side straps and to the top of the triangular piece of leather.

Most Canadian Indians and trappers use four-foot straps or strings to form a fastening similar to the harness just described. The strings may be untied more easily with numb fingers, but the harness has the advantage of being fastened to the snowshoe so it will not be lost.

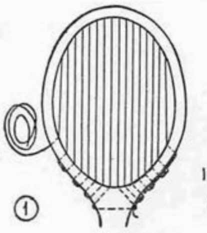
TO make the string fastening, a toe strap must be fitted over the foot and tied securely at each end to the snowshoe filling. Then the strap of soft leather, or lamp wicking, is passed around the heel. Each end is looped under the toe filling and crossed over the foot, one end being passed over and the other under the toe strap. The strings are then looped around the side straps, pulled taut, and tied in a half bowknot back of the heel.

Do not ruin good snowshoes by wearing heeled shoes on them. The heel will soon wear through the filling. Shoe pacs are preferable. The non-waterproofed moosehide pacs are best for real cold weather. In thawing weather or swampy country where you are apt to drop through occasionally into water, waterproofed pacs will keep your feet dry.

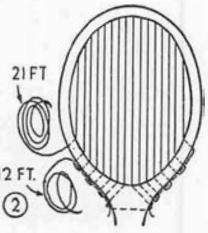
Pacs must be large enough to permit you to wear two or three pairs of heavy wool socks. Rubber footwear is even worse than waterproofed leather. It is fine for Southland swamps, but unthinkable for the cold Northland. Perspiration condenses in such footwear and results in frost-bite.

RUBBER HOSE OF SPECIAL SIZE MADE FROM OLD INNER TUBE

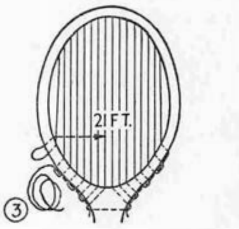
WHEN a short length of rubber tubing or small diameter hose of a certain special size is not available, a substitute can be made by wrapping a strip of inner tube around a wood dowel of the required diameter. Use a wide lap joint and fasten it securely with rubber cement.



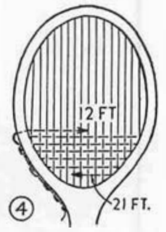
21-FT. STRING PULLED TO ONE SIDE



END OF 12-FT. STRING LAID UNDER LOOPS



CONTINUE DOWN TO THROAT WITH 21-FT. STRING



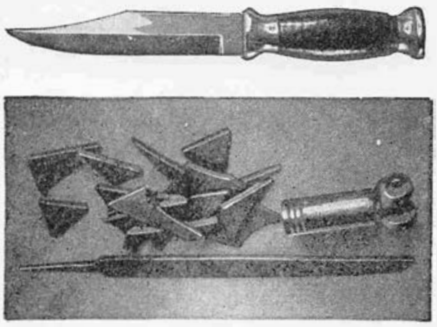
CONTINUE UP TO HEAD WITH 12-FT.

STRINGING YOUR RACKET WITHOUT SPLICING

SHORT lengths of gut (21 and 12 ft. long) have long been used by tennis-racket stringers because they are less expensive and serve the purpose just as well. To make the splice, however, is somewhat troublesome and a lengthy process. It can be avoided as shown above.

Thread the 21-ft. string and pull to one side of the frame, placing the short end under the loops as usual (Fig. 1). Hold the remainder with a stringer's awl. Place the 12-ft. string under the other loops (Fig. 2) and tighten the main string in the regular manner. Thread the remainder up to the next hole and use it for the cross string down to the racket throat (Fig. 3). Then string the 12-ft. length to the head (Fig. 4).

HOW TO CONVERT A FILE INTO A HUNTING KNIFE



The knife and what it was made from—an old file, bits of leather, and a scrap of brass

ALL that was required to make the high-grade hunting knife shown above was a worn-out 10-in. mill file, 10 cents worth of scrap sole leather from a shoe repair shop, and a piece of scrap brass 1¼ in. in diameter.

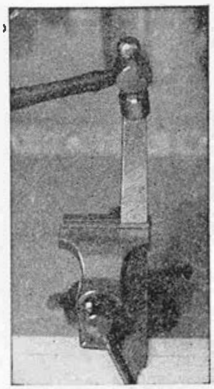
Place the file in a forge or bury it in a roaring bed of live coals in a furnace or stove and bring to a white heat. Remove and let cool gradually. This will leave just the right temper.

Now place the file in the vise with 5 in. above the jaws, and break it off with a hammer. Grind the file down to shape on a coarse wheel as shown in the drawings, and finish on a fine wheel, but do not put a knife edge on the blade until the whole is completed. Thread the end of the tang as indicated.

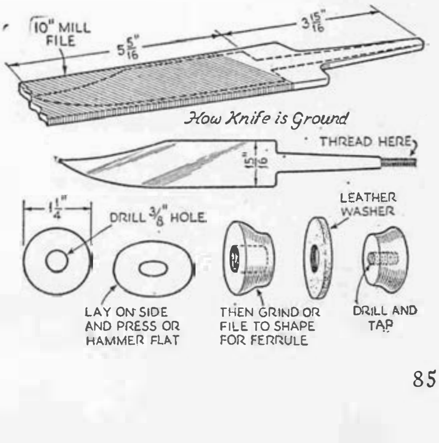
Shape the ferrules on a lathe or by grinding. Anneal the front ferrule by heating to a cherry red and plunging it into cold water. Then drill a ⅜-in. hole through the center. Place the piece on the anvil and drive down flat so that it will slip into place on the tang.

Cut the sole leather into approximate sizes. Drill or punch holes through the centers and slip them onto the tang. Drill and tap the end ferrule, and screw it tightly on the end of the shaft, which has previously been threaded.

Let the knife stand for a few days until the leather has thoroughly shrunk; then turn up the end ferrule as tightly as possible.

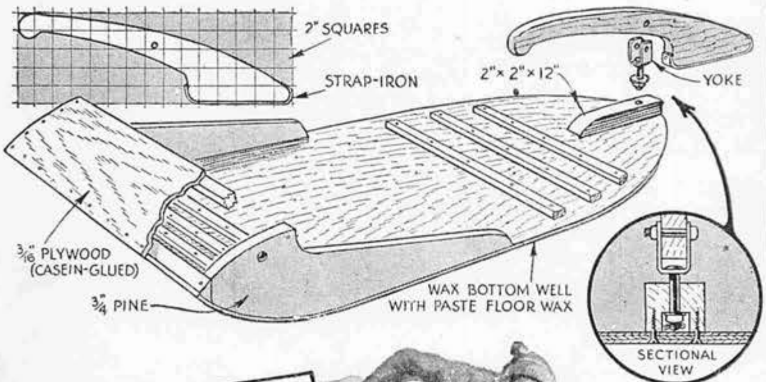


Method of breaking off file in a vise

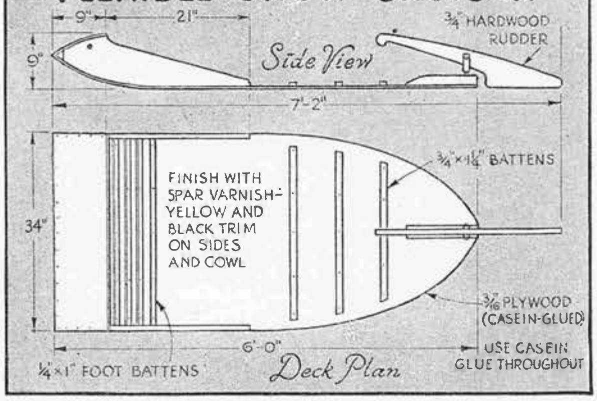


FIVE EASILY BUILT

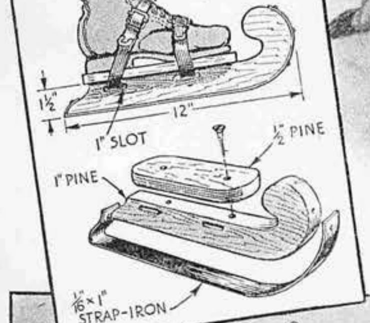
Noveltie*s for* SNOW *and* ICE SPORTS


2" SQUARES
STRAP-IRON
2"×2"×12"
YOKE
3/16" PLYWOOD (CASEIN-GLUED)
3/4" PINE
WAX BOTTOM WELL WITH PASTE FLOOR WAX
SECTIONAL VIEW

FLEXIBLE SNOW CRUISER

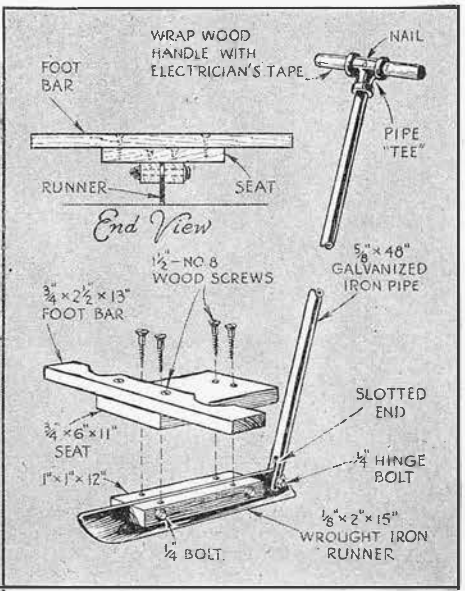

9"
21"
9"
3/4" HARDWOOD RUDDER
Side View
7'-2"
3/4"×1 1/4" BATTENS
FINISH WITH SPAR VARNISH- YELLOW AND BLACK TRIM ON SIDES AND COWL
34"
3/16" PLYWOOD (CASEIN-GLUED)
6'-0"
USE CASEIN GLUE THROUGHOUT
1/4"×1" FOOT BATTENS
Deck Plan

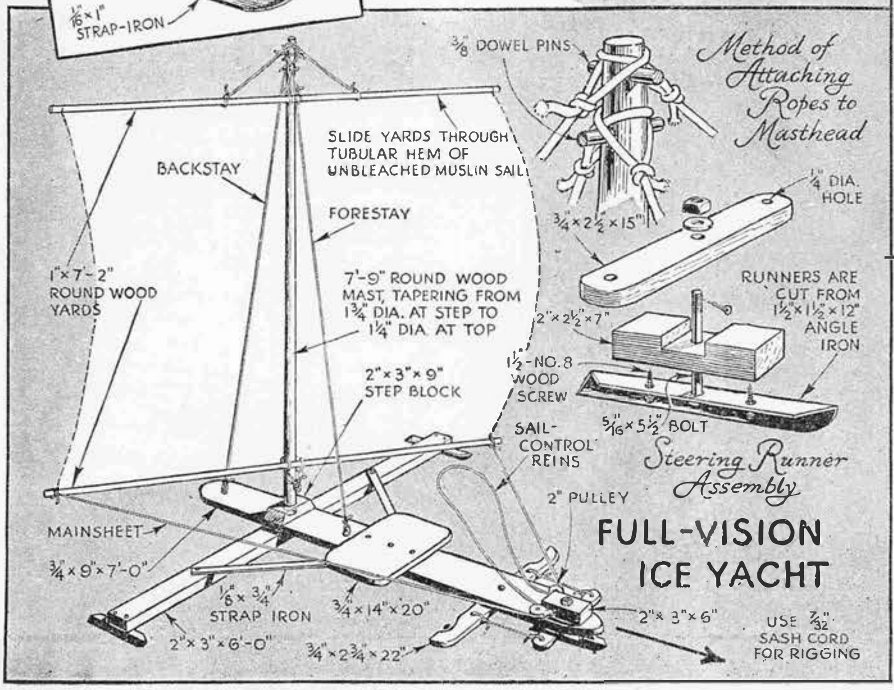
SNOW SKATE *for Children*



SKAGWAY SKIZZER

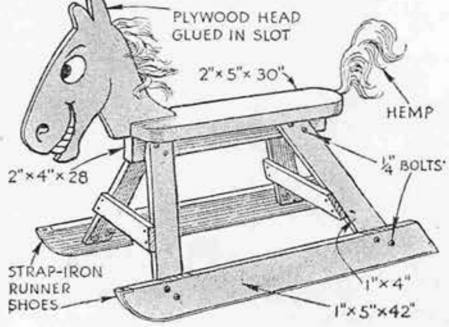
for use on the ice . . .

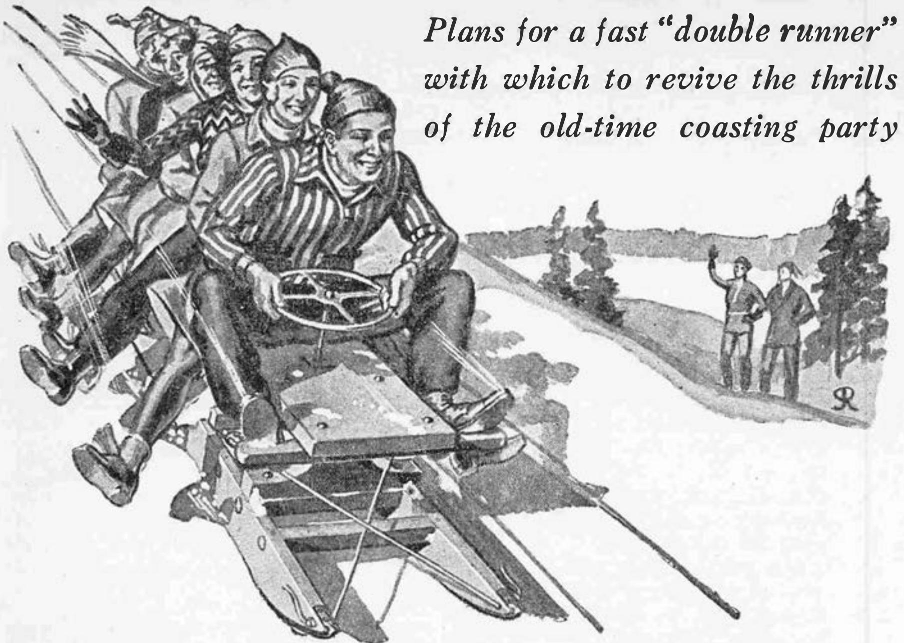




ARCTIC BRONCO

Will carry four astraddle!





Plans for a fast "double runner" with which to revive the thrills of the old-time coasting party

Bobsled Building

A BOBSLED, ripper, or double runner—call it what you will—provides fine winter sport and requires only a little snow, a hill, and a congenial crowd to give no end of thrills. There was a time when a pair of hand sleds suitable for use in assembling a bobsled could be bought, but that day is past, so it will be necessary for us to make our own sleds, as well as the rocker, turntable, steering gear, and seat.

Materials. Hardwood—1 pc. 1 by 4 in. by 14 ft., 1 pc. 1½ by 2 in. by 7 ft., and 1 pc. 2 by 3 by 16 in. for sleds; 1 pc. 2 by 4 by 26 in. for turntable; 1 pc. 2 by 7 by 36 in. and 1 pc. 3 by 4 by 14 in. for rocker; 1 pc. 1 by 2½ by 20 in. for footrest.

Spruce—1 pc. 1½ by 12 in. by 11 ft. for seat.

One spool (either wood or metal) 3 in. long, 5 in. in diameter, with ¾-in. hole for the shaft.

A discarded auto steering wheel with piece of shaft 12 in. long.

Flat iron—18 in. of 1/16 by 2 in. for turntable brace and steering-gear support.

Round iron—20 ft. of ½-in. round iron for braces and runners.

Two pulleys ¼ by 1 in. (with screw eyes) for steering gear.

Manila rope—8 ft. of ¼-in.

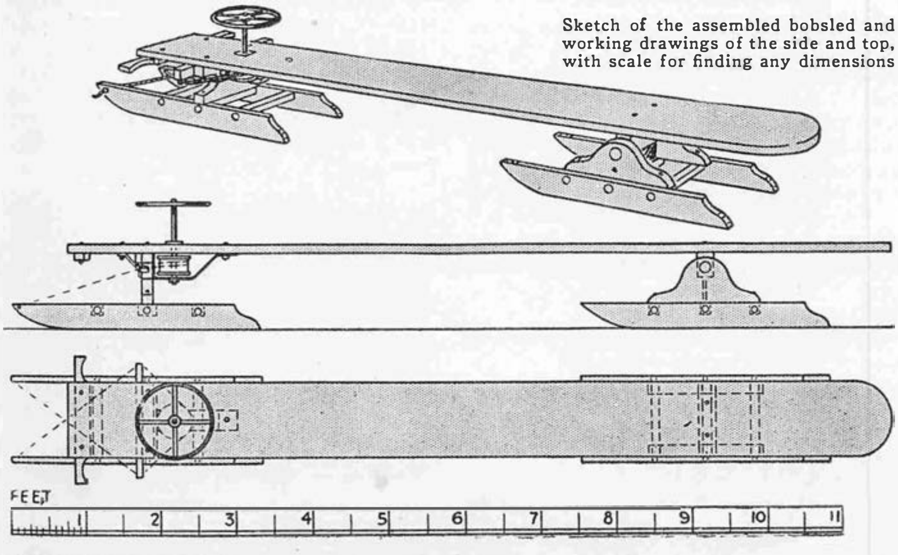
Flathead iron screws, 24 of 1-in.

Carriage bolts: 6—2½ x ¼; 2—3 x ¼; 4—3½ x ⅜; 4—4 x ⅜; 2—6 x ⅜; 1—10 x ½. Flat iron washers for all bolts.

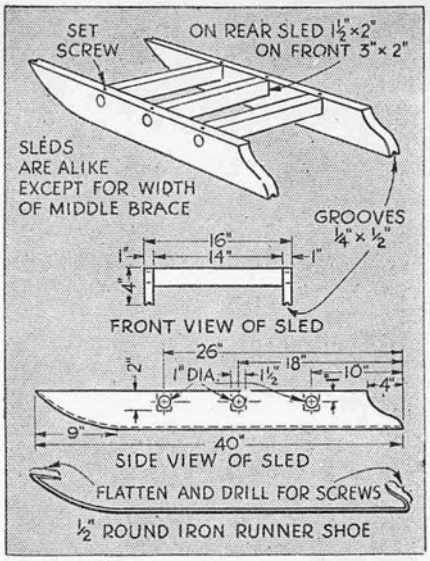
If running boards are to be added: 2 boards ¾ by 3½ in. by 10 ft.; 8 ft. of ½-in. round iron; bolts for the braces and boards.

Tools. Usual woodworking tools and hack saw, drill, countersink, center punch, machinist's hammer, and an anvil or suitable substitute.

Method. The two sleds are made first. They are alike except for the middle brace of the front sled, which is twice as wide as the other two braces. Lay out and cut one runner on 1 by 4 in. board. Use this as a pattern for cutting three more. Bore 1-in. holes for ends of wooden braces, spacing centers 1 in. below top of runner and 10, 18 and 26 in. from rear end. To insure uniformity, clamp two runners together and bore holes at same time.



Sketch of the assembled bobsled and working drawings of the side and top, with scale for finding any dimensions



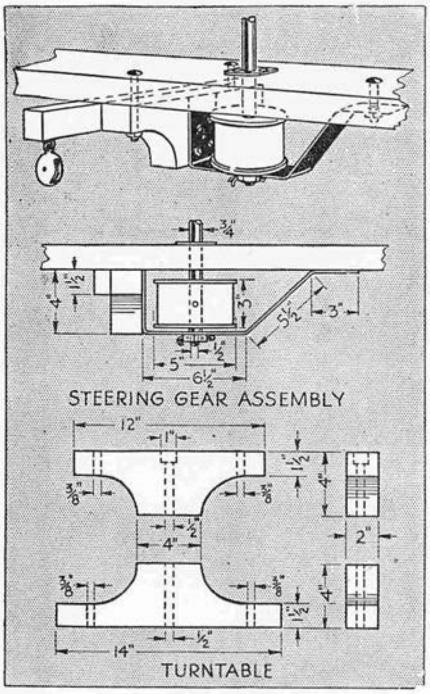
How the sleds are constructed. Note that the front sled has a middle brace 3 in. wide

Cut five wooden braces from 1½ by 2 in. by 7 ft. piece. If lathe is at hand, cut each 16 in. long and turn 1 in. on each end down to 1 in. in diameter; otherwise cut 14 in. long, bore a 1-in. hole in each end about 1½ in. deep, and use a hardwood dowel. In the latter case, both ends of the dowel will have to be held in place with a screw. If the ends have been turned, only one screw is needed through the runner into the brace. The middle brace on the front sled is similar, but 3 in. wide.

Lay out the turntable as shown, being sure all measurements are full. The lower half is bolted to middle brace of front sled with two 3½ by ⅜ in. bolts. Find the exact center of this half of the turntable and bore a ½-in. hole through it and the brace to receive the lower end of the 10 in. bolt.

For the rear sled, lay out two rocker supports on the 2 by 7 in. piece. Locate center of hole before cutting. When both supports are cut, clamp them together and bore holes for the rocker journal. This journal must be either turned down on a lathe or else carefully worked down with a chisel. It is not in the exact center of the 3 by 4 in. crosspiece, but ½ in. below center horizontally and on center vertically. The fit should not be loose, neither should it bind. Four 4 by ⅜ in. bolts fasten the rocker supports to the sled. Clamp the supports to the braces to prevent slipping, and bore holes through both at once.

Remove turntable, rockers, and cross braces from runners. Drill and countersink a hole for a 1-in. screw from the top of the runners into each cross-brace hole. Turn runners upside down and cut a groove ½ in. wide and ¼ in. deep the full length of the bottom. Heat the end of a ½-in. round iron rod and flatten for 2 in. At this end also curve the rod to fit end of runner. Continue curve around entire toe of runner and along bottom. When heel is reached, allow about 2 in. and cut off. Heat the heel end, flatten, and bend to fit around heel of runner. Drill and countersink two holes in each flattened end of iron. Repeat this operation for each runner, then proceed with the general assembly. The iron runners, however, are not put on until the bobsled



Method of mounting the steering drum and pulleys, and layout for the turntable parts

has been completely assembled and painted.

After the rocker and rocker supports are in place, the supports must be braced with iron rod as shown. This brace is 20 in. long, flattened at one end for 3½ in., bent at an angle of 45 deg., and, beginning 5 in. from the bend, flattened again for 3 in. At the 5-in. point, bend to 135 deg., and at the end of the flat, to 135 deg. again. Measure 5 in. from this last bend and flatten again for 3½ in. and bend to 45 deg. Drill a ¼-in. hole in the middle of each 3½-in. flat and two holes in the 3-in. flat. Place this between the two rocker supports, and bolt to the supports and cross brace with 2½ by ¼ in. bolts.

THE spruce seat should finish about 1½ by 12 in. by 11 ft., with the rear end cut to a semicircle (or curved to some degree) and the front end square. The top half of the turntable is placed 12 in. from the front end, but before it is bolted, the 10-in. pivot bolt is inserted. Bore a 1-in. hole in the center of the turntable deep enough to allow the head of the bolt to drop just below the surface. Using the same center, bore a ½-in. hole the rest of the way through.

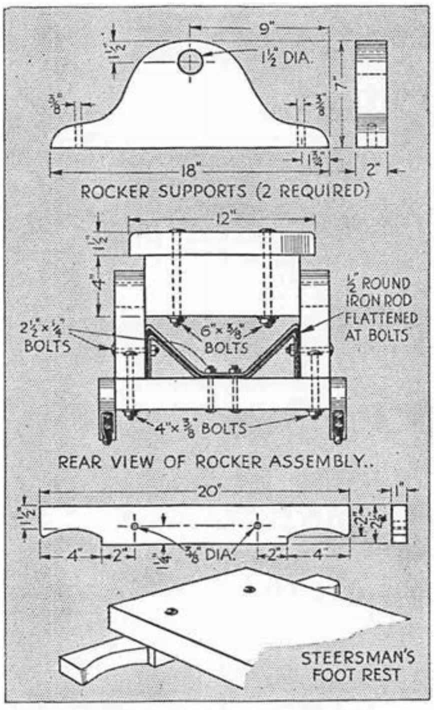
With the bolt in place through both halves of the turntable, turn the nut up on the lower end until about 1/16 in. from the wood. Mark the place, remove the bolt, and with the nut up to the marked place, drill through nut and bolt for a cotter pin. Put the bolt through the top half of the turntable and bolt this half to the seat. It is then braced to the seat at the front with a piece of iron rod flattened at both ends and bent to make an angle of 45 deg. between seat and upright. The front end is bolted to the seat, but the other end is put on with screws as the pivot bolt prevents bolting this end.

The footrest for the steersman is cut as shown and bolted to the front end of the seat on the underside. A piece of softwood about 1 by 1½ by 18 in. is fastened to the underside of the seat between the turntable and the iron brace for holding two pulleys.

The steering gear will entail a trip to a machinist unless you happen to have a metal lathe, taps, and dies. The spool may be wood or metal, 3 in. long, 5 in. in diameter, with a ¾-in. hole through it for the shaft. If metal, it is fastened to the shaft with a key or set screw; if wood, with a pin or bolt. Be sure there are no projecting ends for the rope to catch on.

The shaft is about 12 in. long over all, with the lower end turned down to ½ in. in diameter for about ½ in. and threaded to receive a nut. The nut is put on, leaving a good 1/16 in. between it and the shoulder, and both nut and shaft are drilled for a cotter pin. The spool is placed on the shaft so that there will be about ¾ in. of the shaft projecting below.

The steering gear support also serves as a brace for the turntable. It is made of 2-in. flat iron with three bends—the first 4 in. from one end, the second is 6½ in. from the first, and the third is 5½ in. from the second. The first bend is 90 deg.; the other two are each 135 deg. A ½-in. hole is drilled through the center of the 6½-in. length, and the iron is cut off 3 in. beyond the last bend. Four screw holes are drilled and countersunk in the 4 in. surface, and a ¼-in. hole for a bolt is drilled in the 3 in. end. The 4-in. end is fastened to the rear of the turntable, and the other end bolted to the seat board.



Rocker supports for the rear sled, how they are fastened and braced, and the foot rest

A ¾-in. hole for the shaft bored through the seat directly over the ½-in. hole in the support. This will be stronger if a short piece of the 2-in. iron is also drilled ¾ in. and placed around the hole.

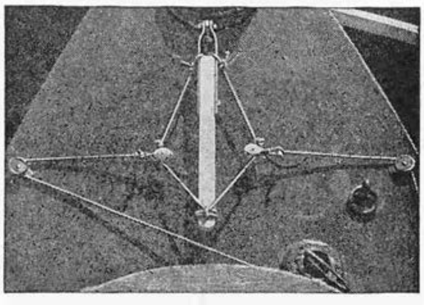
The seat is now fastened by inserting the pivot bolt in the lower half of the turntable and bolting the rear sled rocker to the plank. The rocker should be placed about 2½ ft. from the extreme rear of the seat.

Bore a ¼-in. hole through the toe end of each forward runner, just inside the irons, for the steering rope. To hook up the rope, tie a knot in one end and pull the rope through one of the ¼-in. holes (from the outside towards the center) and pass it through the pulley on the opposite side. Continue on around behind the spool, taking one or two turns around the spool, and bring the end back through the other pulley and out through the remaining ¼-in. hole. Pull the rope as tight as you can and tie a knot securely in the end.

The entire sled should be given three coats of paint, preferably bright colors such as red, green, or blue. After the paint is dry, the runner irons are put on and polished with emery cloth and steel wool.

If running boards are desired, they can be made of softwood about ¾ by 3½ in. by 10 ft., and braces can be made by bending and flattening the ends of ½-in. round iron. The braces, four to a side, are bolted to the underside of the seat, and the running boards are bolted to the braces.

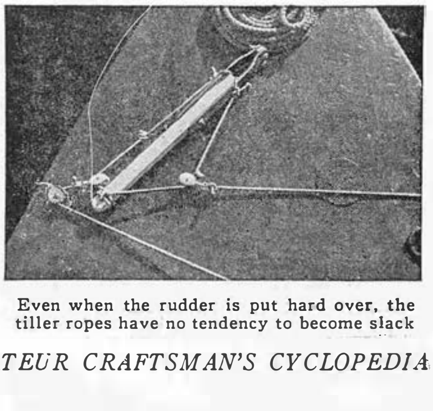
BETTER WAY TO HOOK UP SMALL BOAT'S TILLER



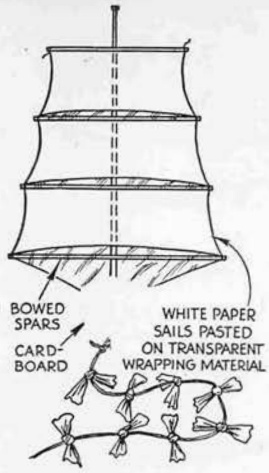
The tiller ropes are fastened to two small pulleys that run along short pieces of rope

THE greatest disadvantage of the ordinary system of rope-and-tiller steering for small boats is the tendency of the ropes to slacken considerably when it is least desired, that is, when the rudder is put hard over to one side. The photographs illustrate a system that completely eliminates that tendency. It is so simple to install that very little time or effort is needed to make the change.

Instead of being fastened to the end of the tiller, the tiller ropes are fastened to two small pulleys that run on short pieces of rope joining the ends of the tiller. As the tiller moves to one side, the pulley on that side moves out toward the end of the tiller, while a knot in the rope prevents the other pulley from moving toward the rudder stock and slackening the tiller ropes. Since the tiller ropes remain at all times in the straight line joining the deck pulleys, the effect is very nearly the same as if a steering quadrant were used.



Even when the rudder is put hard over, the tiller ropes have no tendency to become slack

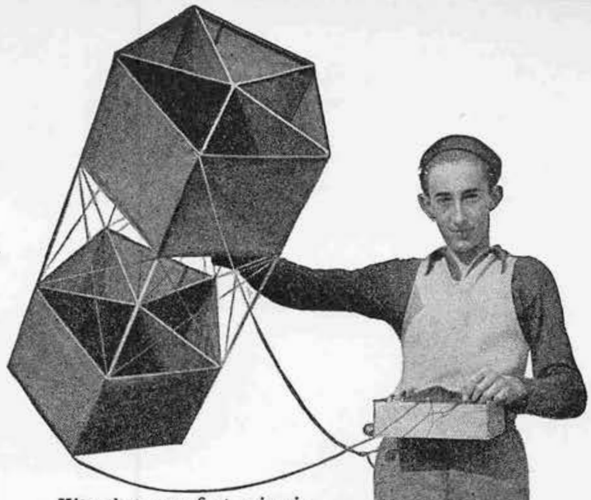


Suggestions for Making

KITES

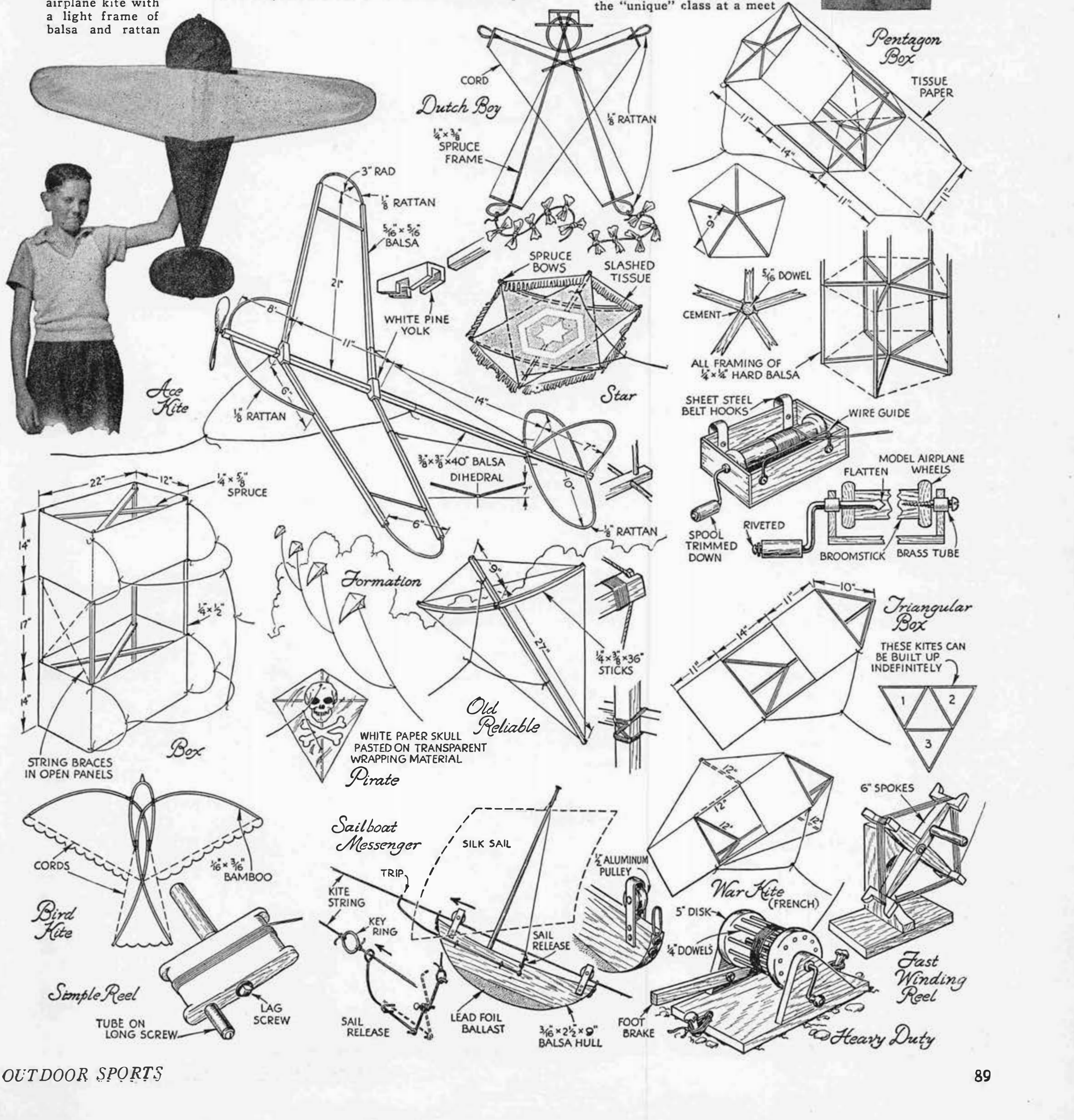
Messengers and Reels

LET your imagination and ingenuity have a chance, the next time you build a kite. Here are a number of suggestions. Note particularly the pentagon box kite by Elwood Yeager, of Pasadena, Calif., and the reel he uses when flying it. The sailboat messenger at the bottom of the page is another novelty; when it reaches the kite, its sail is automatically furled and it slides down again.



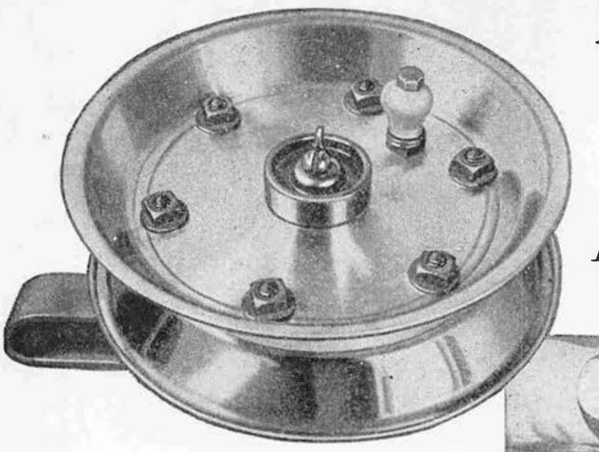
Kite that won first prize in the "unique" class at a meet

Below is shown an airplane kite with a light frame of balsa and rattan



Ball-Bearing REELS

FOR KITE FLYING OR TROLLING



The completed reel is held on the central bolt with a wing nut. Note the small wooden handle

Roller-skate wheels and aluminum pie plates used in making line holders of large capacity

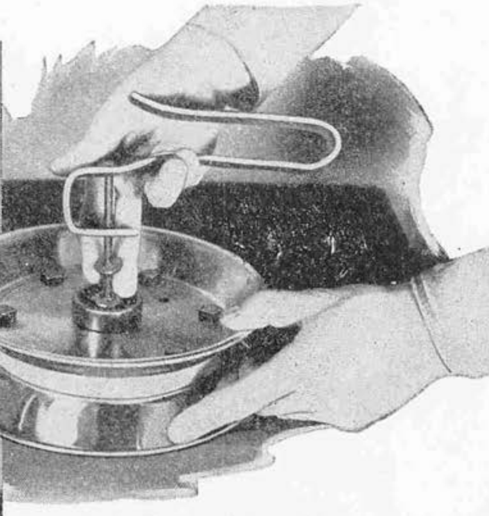
THREE ever-present problems confront the person who wishes to construct a reel, whether for use in flying a kite or trolling without a pole from an open boat. They are large capacity for holding line, quick take-up, and freedom from excess bearing friction when there is a strain on the line. While reels that meet these requirements may be purchased, they are expensive.

The two sturdy homemade reels illustrated are of large capacity and neat appearance. They will take up about a foot of line at each revolution, and the skate-wheel ball bearings eliminate friction.

The construction of the reels is simple, and the materials are readily obtained in any locality. Ordinary aluminium pie plates of about the 8-in. size are used. Tin plates should not be used as they are too flimsy and rust quickly. The center of each plate is found, and the positions of the six bolts are laid out on one of the plates. Though the size of the center hole in most ball-bearing skate wheels is ¼ in., there may be some variation. It will be assumed, however, that the standard size is being used, and this requires that a ¼-in. hole be drilled in the center of each plate.

In the smaller size reel, the plates may be bolted directly together, but the line capacity and the strength are greatly increased if a ½-in. disk is turned and drilled with a center hole to be inserted between the two plates.

In the larger reel two disks ¾ in. thick are turned to fit the plates and drilled with center holes. The plates and disks are placed together and secured with a ¼-in. bolt through the center hole. Holes for the six 5/16-in. bolts are then drilled through the assembled disks and plates. It is advisable to mark the plates and disks for reassembly in the same positions.

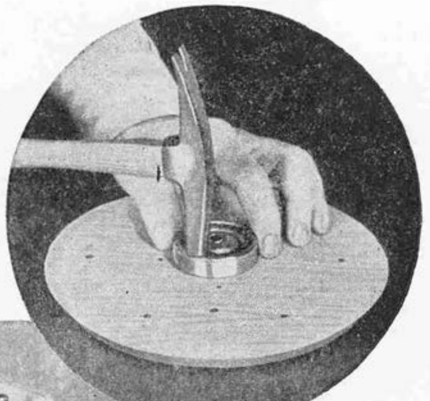


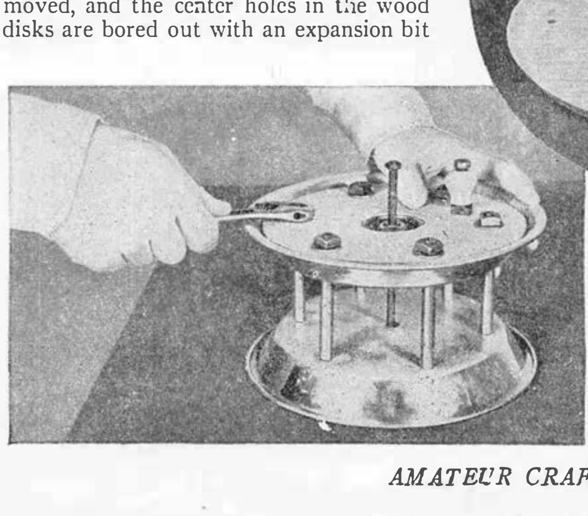
How the trolling bracket or other support is fastened to the reel. The wooden disk between the two pie plates is also clearly visible. At the left is shown the drilling of holes to secure the wheel

To assemble the smaller reel, the center bolt is removed, a longer one is slipped in, and the skate wheel is placed over it. Then ⅛-in. holes are drilled through the wheel and plates to take the bearing bolts. Do the same for both bearings. This method will make the reel run true. The reel is now taken apart, the center holes enlarged to ½ in., and recesses cut in the disk for the bearing bolts. A 5/16-in. hole is drilled for the handle pivot bolt, which is locked in place with a nut on either side of the reel. The handle is turned on a lathe and bushed with a piece of 5/16-in. inside diameter brass tubing, forced in by hand.

In the larger reel, the center bolt is removed, and the center holes in the wood disks are bored out with an expansion bit to take the skate wheels in a light tap fit. The center holes in the plates are drilled out to ½ in. The hole for the handle is drilled, and the reel is assembled with 5/16-in. inside diameter brass tubing slipped over the bolts as spacers.

A bracket for trolling also is shown. This is shaped from ¼-in. strap iron, and is slipped over the seat of the boat. For kite reels, a similar bracket can be made and strapped to the operator's body.



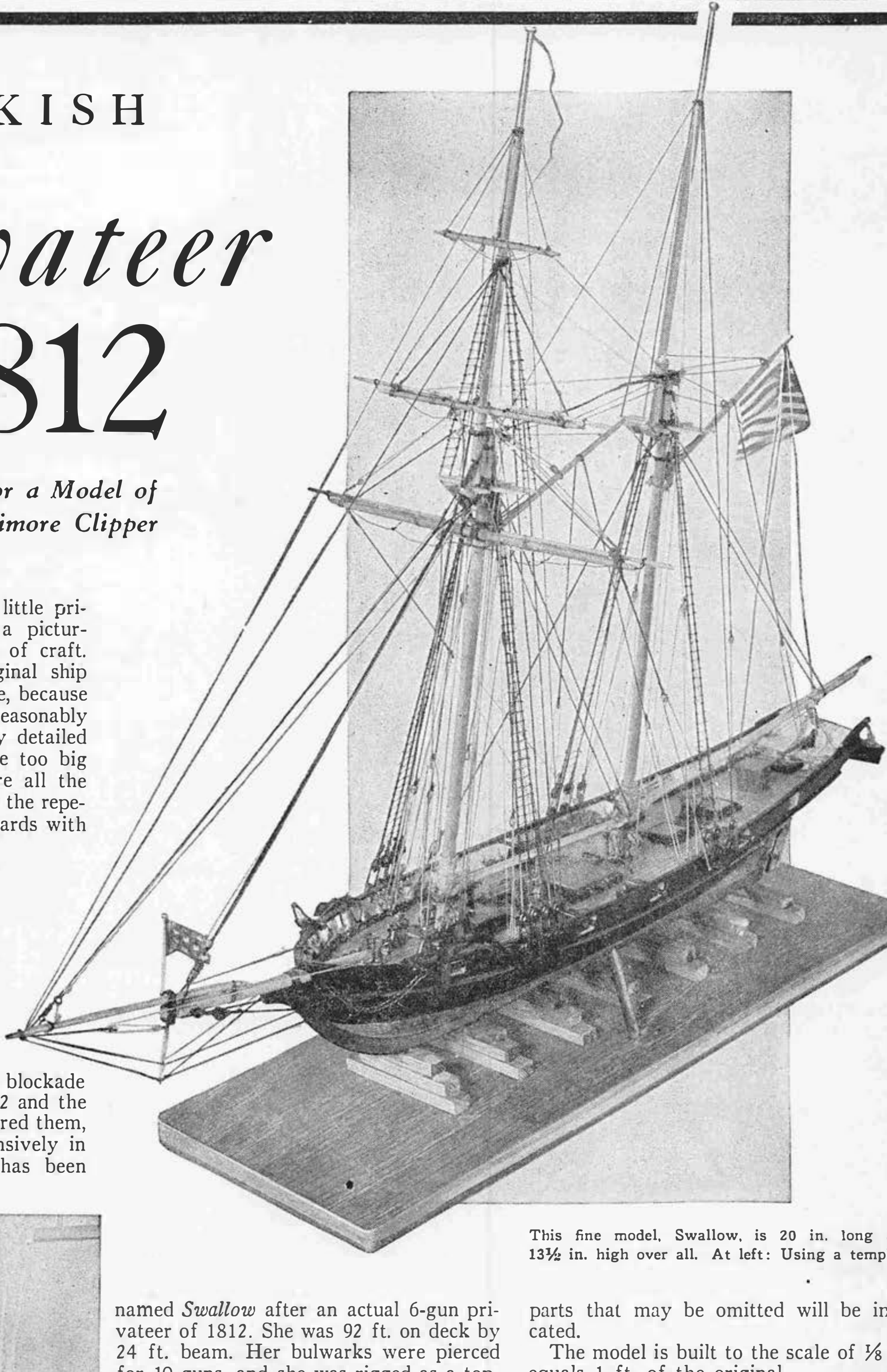


If a reel of still larger capacity is required, it is assembled as shown at the left. The plates are held apart with brass tubing slipped over the bolts. In this case the skate wheels are tapped into large holes bored in the wooden sidepieces, as illustrated above

MODEL MAKING

A RAKISH *Privateer* of 1812

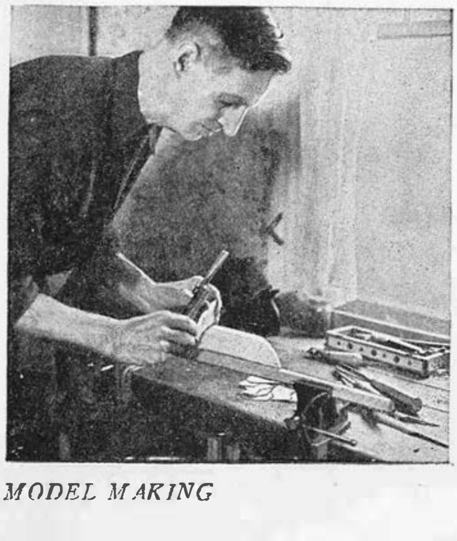
Complete Plans for a Model of The Famous Baltimore Clipper



YOU'LL like this rakish little privateer *Swallow.* It is a picturesque and unusual type of craft. The fact that the original ship was small, is a distinct advantage, because it enables one to work on a reasonably large scale and make a carefully detailed model, yet one that will not be too big for the average room. Here are all the essentials of a large ship without the repetition of numerous masts and yards with their gear.

The Baltimore clippers were probably evolved from the Jamaica-Bermuda sloops, possibly influenced by the French *chasse-marée* type of the mid-eighteenth century.

These clippers were the speediest ships afloat and consequently were much in demand for privateering and blockade running in both the War of 1812 and the Civil War. The pirates also favored them, and they were later used extensively in the slave trade. This model has been named *Swallow* after an actual 6-gun privateer of 1812. She was 92 ft. on deck by 24 ft. beam. Her bulwarks were pierced for 10 guns, and she was rigged as a topsail schooner, as illustrated above.



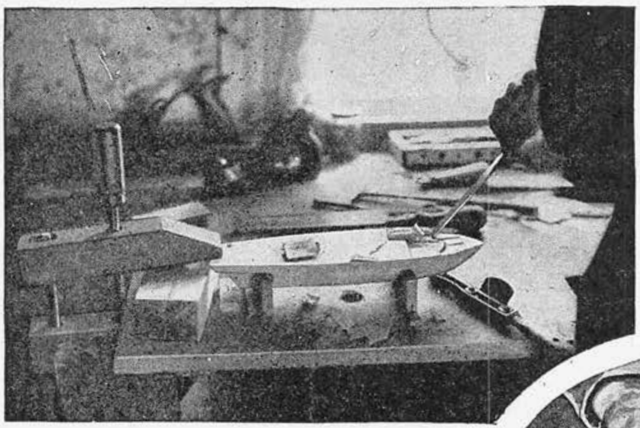
This fine model, Swallow, is 20 in. long and 13½ in. high over all. At left: Using a template

The lines are from those taken off at Baltimore in 1820 by M. Marestier, a French naval engnieer, and published in his bock, *Memoire sur les bateaux a vapeur des Etats-Unis d'Amerique.* The sail plan is adapted from the same source.

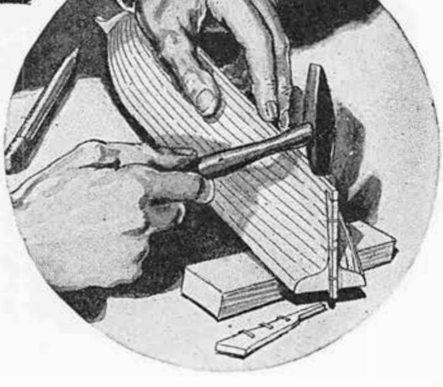
This model is being presented so that it can be made in form and detail equal to the very best models, or simplified to form a good project for the beginner, so parts that may be omitted will be indicated.

The model is built to the scale of ⅛ in. equals 1 ft. of the original.

For the hull take four pieces of soft pine or other suitable wood (not balsa) 12 by 3¼ by 7/16 in. (which is the usual thickness of ½-in. dressed boards). Make a full-size drawing of the breadth plan or, if you are using blue prints, cut out the breadth plan or make a tracing of it. Scribe a center line down each piece. Pin the breadth plan on one piece of wood with the center lines coinciding. With carbon paper transfer one line (say



How to clamp down the hull firmly in order to shape the deck to the proper sheer. The planks are marked in with a hard lead pencil



Nailing the keel. The effect of planking is obtained by drawing lines with a flexible straightedge and scratching them in accurately

a) to the board and also mark the construction lines I to XI. Mark *b*, *c*, *d* similarly. Cut away the waste to within about 1/16 in. of these lines. With a try-square carry the side and center construction lines over the edges.

The model will be lighter and less liable to warp if you hollow pieces *b* and *c* to within about ¼ in. of the sizes of the pieces below them. All this can be done with jig saw. Glue these together with all lines coinciding.

Onto stiff cardboard or other thin material, scribe the body plan lines as was done for the hull lifts, and make a template for each line, marking on them where line *b* cuts. After cutting these templates, place them on the body plan and test for accuracy.

Fasten the glued-up hull, bottom side up, by any convenient method. Screwing the top to a stick with octagonal ends to be held in vises is the best, but holding in a bench vise or between the knees will serve.

First make templates from the sheer plan of the stem and stern, carrying them a few inches along the keel and marking on them the construction lines. Saw and file the hull to these lines.

Shave away the waste from the sides, making long cuts from the middle until all the templates fit accurately in their respective positions when held at a right angle to the keel line and mark *b* at the junction of pieces *B* and *C*.

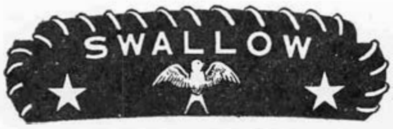
Leave a full ⅛ in. flat at the ends for the stem and sternpost to fit on. Bring the hull down exactly and sharply to the latter when fitted. The deadwood at the stern is flat and the same thickness as the keel, but leave it a bit thick until the latter is on.

A spokeshave will do most of this work, with the aid of a wood file at the bow and stern and any other tools, such as chisels and gouges, you may care to use. Remember that heavy sandpapering takes off an appreciable amount. Leave the final smoothing until ready to paint.

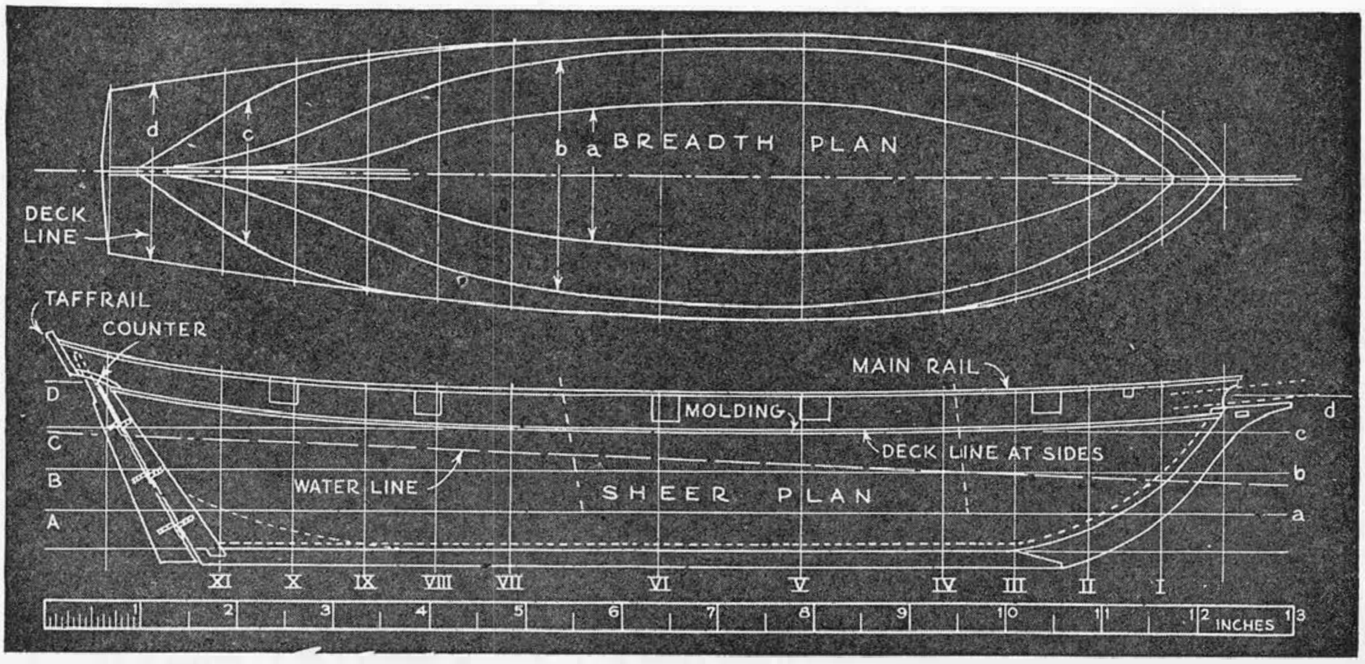
Set the hull upright on the bench. With a small, much curved model such as this, it is not easy to keep it firm, so proceed as follows: make a working base or stand for the hull. The uprights are cut to the shape of templates IV and X, nailed to a board, and lined with cloth. Then get a block of wood the height of the hull at the stern, set the lower jaw of an adjustable clamp in the bench vise, and clamp down on the block and the baseboard with the end of the jaw projecting over the hull.

From the sheer plan mark the edge of the deck up from line *c*. Mark another line ⅛ in. higher than this for the curve across the deck. Set the hull in its base, and chisel and spokeshave or plane away the waste to the upper line. The wood will come out easier if you make a few cross saw cuts almost to the line. Shave this part—the deck—until you have an even curve, meeting the underdeck line at the ends, but a full 1/16 in. higher at the widest part; then curve it down to meet the deck line at the sides all the way along. The standard curve of a deck is ¼ in. to the foot.

The stem, sternpost, and keel should go on next. From a piece of scant ⅛-in. hard or semihard wood, cut these to the shape shown on the sheer plan. The stem and keel should be set in a groove in the hull, which can be made with a wide saw cut and looks best if properly scarfed together, but it is less trouble to make the stem a bit long and cut it level with the bottom of the hull. Then set the keel under it and round off the end. The same applies to the sternpost. You do not then



The taffrail drawn full size. It looks best if white on black, exactly like this



Full-breadth plan and sheer plan with station lines corresponding to those marked on the body plan given at the top of the next page. The deck plan with a side view of the deck fittings and a template for the bulwarks appear opposite. All drawings are to the same scale.

Materials for Hull

4	pc. 7/16 x 3¼ x 12 in. white pine. (Dressed ½-in. pine is 7/16 in. thick.)
1	pc. ⅛ x 1 x 3½ in. hard or semihard wood for stem, stern, rudder.
1	pc. ⅛ x 3/16 x 10 in. hard or semihard wood for keel.
2	pc. 1/16 x ¾ x 13 in. pine or semihard wood for bulwarks.
1	pc. ⅛ x 2 x 4 in., or equivalent, hard or semihard wood for catheads, stern knees, counter, etc.
1	pc. ⅛ x 1¾ x 2 in. semihard wood for counter and taffrail.
40	inches of ⅛ x ⅛ in. semihard wood for waterways and moldings.
90	inches of 1/16 x 3/32 in. pine or semihard wood for timberheads.

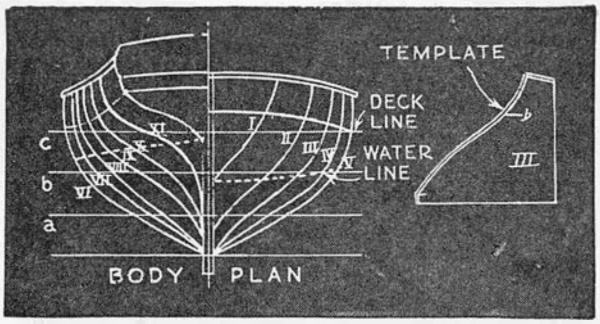
Scraps of hard or soft wood for deck fittings.

NOTE: All wood to be dressed to correct dimensions as shown in drawings.

need to set the keel in a rabbet. Glue and lightly nail these parts on firmly.

For the bulwarks, two pieces of wood that will work nicely, such as whitewood, gum, or holly, are needed. They should be 1/16 by ¾ by 13 in. First take a strip of cardboard, hold it or pin it outside the hull, flaring out at the bow and a little at the stern; and with a sharp pencil, mark the edge of the deck line on it. Draw a line ⅜ in. from this in the middle, but a shade wider at the ends. Cut this out, when it should be about like the bulwark piece shown, which should exactly fit the hull, but will not if your lines vary from the lines given. This principle applies to all parts. It is best to make templates first.

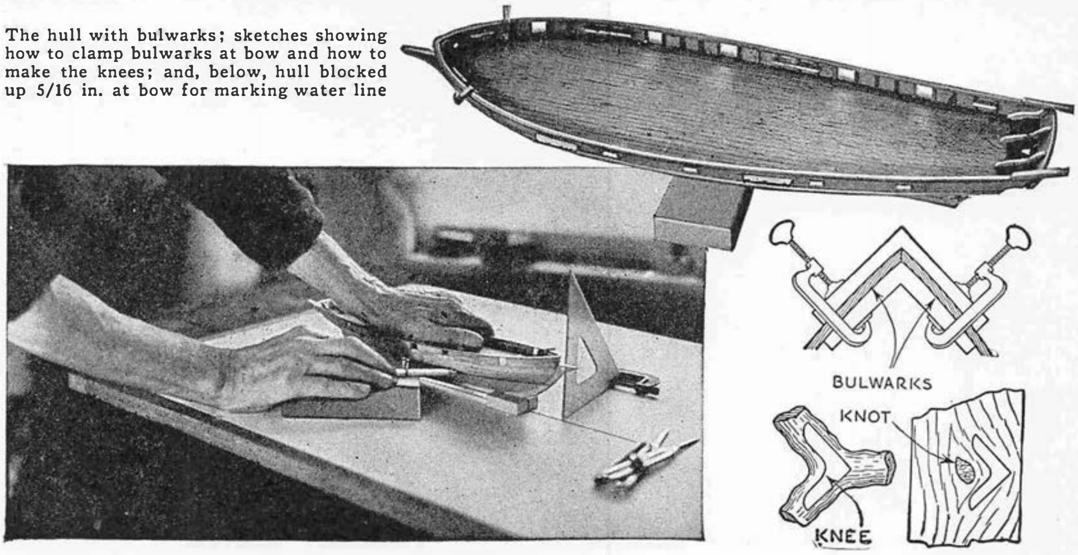
Having got the bottom line of the bulwarks right, cut your wood to it, but leave the top amply oversize. A slight bevel will be needed at the ends to allow the bulwark to fit flat on the deck where it flares out, as shown on the body plan. This piece goes onto the deck with its outside edge flush with the hull. The forward ends will probably need steaming to bring them to shape. If you have a kettle with a big spout, put them down that for a while; if not, soak them in boiling water for about twenty minutes, then bind them with a cloth around a coffee can and leave them to dry. Be careful to bend each one in the right direction.



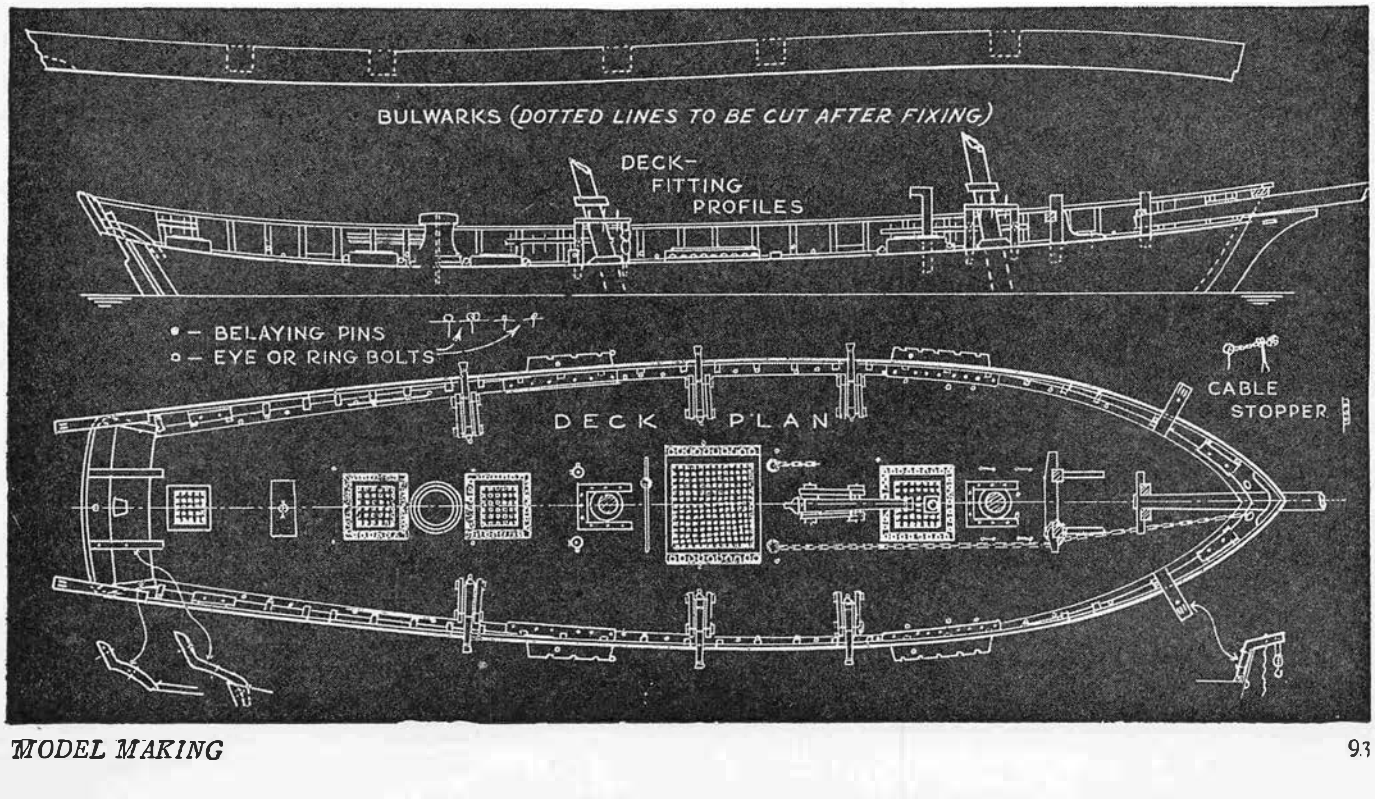
The body plan from which templates should be made to aid in shaping the hull. A template for station III is shown

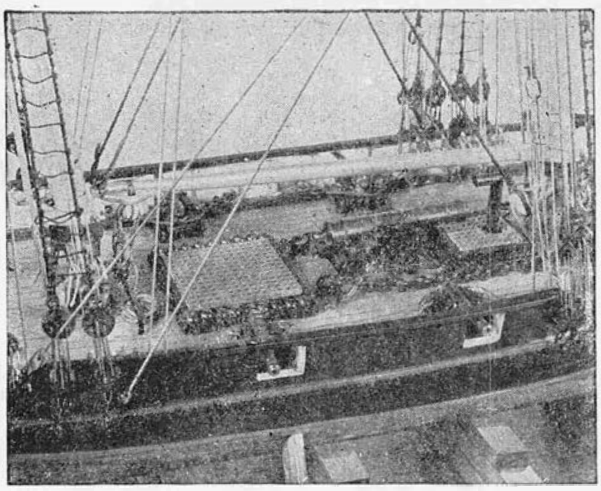
While the bulwarks are drying, put in the waterways. These are strips of wood 3/32 by ⅛ in. wide. Make a pencil mark on the deck, in from the edge the exact thickness of the bulwarks, and glue and nail these strips to the deck, leaving what amounts to a rabbet for the bulwarks. The waterways will probably need steaming. They are cut to meet the inside part of the stem and extend right aft to follow the line of the stern.

To make a nice join at the stem, the bulwarks should be steamed a shade more round than needed. Let the first piece extend beyond the enter line, stretch it



The hull with bulwarks; sketches showing how to clamp bulwarks at bow and how to make the knees; and, below, hull blocked up 5/16 in. at bow for marking water line





The midship section of the model. The large hatch has troughs on each side for carrying miniature cannon balls

along, and glue and nail it in position, leaving an overhang aft. Then cut it down on the midship line and cut the other to meet the first, and repeat the process. If you have difficulty here, make a knee like that shown on the deck plan only much heavier, and another similar one to fit onto it, and put one inside and one outside the bulwark and clamp them together until the glue is set and you have a few nails in. Then remove these and put in the permanent knee. For this you can cut a fork from a tree twig or pick out wood grain running around a knot. You can find such a place on a piece of holly from which to cut all your knees.

The hole for the bowsprit is next cut, and the bulwarks are shaved down to stand ⅜ in. high, vertically, all along. The gun ports are also cut, all vertical.

The counter at the stern is quite tricky to make. It is easier to cut and file it from the solid, rather than to bend it. A piece 3/16 in. thick is required. It projects its thickness (3/32 in.) onto the hull and fits inside the bulwarks; the lower and upper edges are curved to the camber of the deck, and it curves vertically to the lines given on the sheer plan. Fit it first to the deck and bulwarks, then to the outside curve. The inside must curve to correspond. Finally the top curve is formed and that edge is made vertical to receive the taffrail abaft.

The ends of the bulwarks are then cut to the same curve and above to the correct angle to take the taffrail. The latter projects beyond the bulwarks, is level with the counter, and curved above more than the camber. It is also curved athwart. Carve a rope pattern round the top and sides, paint the ship's name on it, and cut out of cardboard a little eagle and two stars for decoration. The taffrail has to be slightly notched at the corners so that the boat davits will lie flat on the main rail. Strengthen this part with two knees cut to the inside shape and set into the deck, and also with knees in the corners, coming down onto the waterways.

The junction of the bulwarks and the hull is covered with a narrow molding, a bare 1/16 in. square, with the outside corners rounded. This is glued on and held in position with a few pin points. Paint this crimson.

Along the inside of the bulwarks, the timberheads should be shown. These are supposed to be the ends of the hull ribs, but if we set them from the waterways to the top of the bulwarks, that will do. They are a scant 1/16 in. by a full 1/16 in., and are merely glued in the positions shown. Be careful to have one on each side of the gun ports. They are best cut a bit long, then their ends are cut level with the bulwarks. Hold them to the bulwarks with pliers, or clamps and slice them off with a razor blade, or file them level.

The main rail comes next. This is ⅛ by 1/16 in. and is glued and nailed along the bulwarks and timberheads, projecting outside about 1/32 in.

Copper sheathing was not usual in vessels of this size. The underwater body probably was painted, but it looks well if stained brown and lightly varnished. Hulls above the water line were painted black, green, yellow, and so forth, but black was the usual color and is the best looking, so make it black with a red molding.

With this kind of hull, marking the planks looks well if nicely done, but badly done, it is an eyesore. Our ship probably had about thirty planks a side, but this would, on the model, be too close. Give it about twelve planks. With a piece of paper measure from the deck to the keel at the widest part (V), divide this into twelve, mark these positions. At stations III and IX do the same. With a flexible straightedge, draw lines through these, letting the ends run up so that you get a kind of fan appearance at the ends. Scratch a line along these lines and clean them out with a needle file. This is best done while the hull is still on the shaping stick.

Mark in the water line as shown, using a scriber or pencil. Note especially that the water line is not parallel with the keel; therefore raise the bow, at the scarf, 5/16 in. Be careful that the hull is upright and firm.

The deck can also be scribed to represent planks. Make the lines about 1/16 in. apart and straight from end to end. They can be made with a very hard pencil. Do not score the deck deeply or make the lines very black. The deck should be lightly varnished.

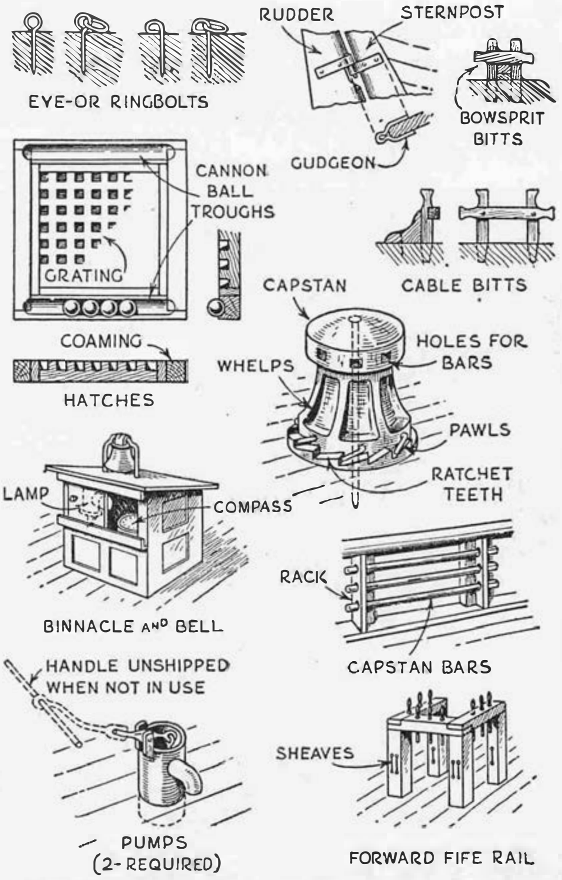
The inside of the bulwarks can be white, red, or other color. A dull red looks well, or you can use white with red waterways.

Coach colors are the best for this work, but any color can be used that will go on thin and not dry with a shiny finish. A satiny glow is what is wanted throughout. If the deck is varnished with clear lacquer, then parts cermented to it with a cellulose cement will stick firmly.

Where nailing is mentioned, the best things to use are ½-in. bank pins (lills). Drill holes to start them right, tap them part way in, snip the heads off, then complete the hammering lightly, which will form a sufficient head.

Any kind of glue can be used, but casein (cold-water) glue is perhaps the best and easiest to work with for the hull, and a cellulose cement for other parts. Both are waterproof.

There are a few parts of the hull proper yet to be added. It would be more logical to apply them before the painting, but if the painting has been done, just scrape



These drawings show the shapes but not the relative sizes space on which to glue the other parts.

The channels to spread the rigging are four hardwood pieces, slightly thicker on the inside and with notches to take the deadeye straps. Their shape and positions are shown in one of the photographs and the deck plan.

As the pinrails are placed in the same positions, only inside the bulwarks, make them also. They are thinner, as shown in the deck plan and profile drawing of the deck fittings, and have to be notched to take the timber heads. Glue all these in position, then nail right through from the outside with ½-in. pins. There are also pinrails forward and aft. The belaying pins can be bought ready-made or turned from brass rod, although for a simple model headless pins, painted brown, can be used. Drill holes to make them a tight fit. If brass is used, stain it brown. You can use ¼-in. pins, which are a bit over scale but as small as is practical; in fact, 5/16-in. pins would do. Note that belaying pins are indicated by solid round dots on the deck plan, and all the eye- or ringbolts by small circles drawn in outline.

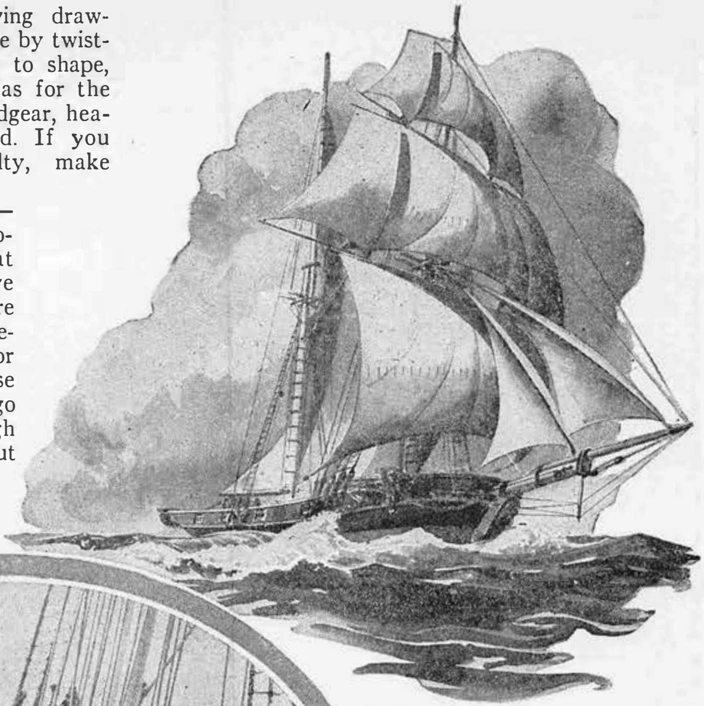
The channels are black and the pin rails brown. The channels need an eyebolt each, and one in the forecorner of the after ones. Details of eyebolts and ringbolts are shown in the accompanying drawings. They are made by twisting the small pins to shape, or in some cases, as for the mainstays and headgear, heavier pins are used. If you have any difficulty, make little staples.

The catheads—the L-shaped projecting timbers at the bow—also have to go on. These are best set in place before the main (or cap) rail because they should go under it, although they may also cut through it. For these try to find a piece of twisted grain, or make them from twig forks, although a piece of hardwood cut diagonally will serve. The upright part lies on the bulwark against a timberhead and is nailed and glued in position. The outer end slopes slightly up and has four holes drilled in it for the cat tackle, and another inside for the stopper rope.

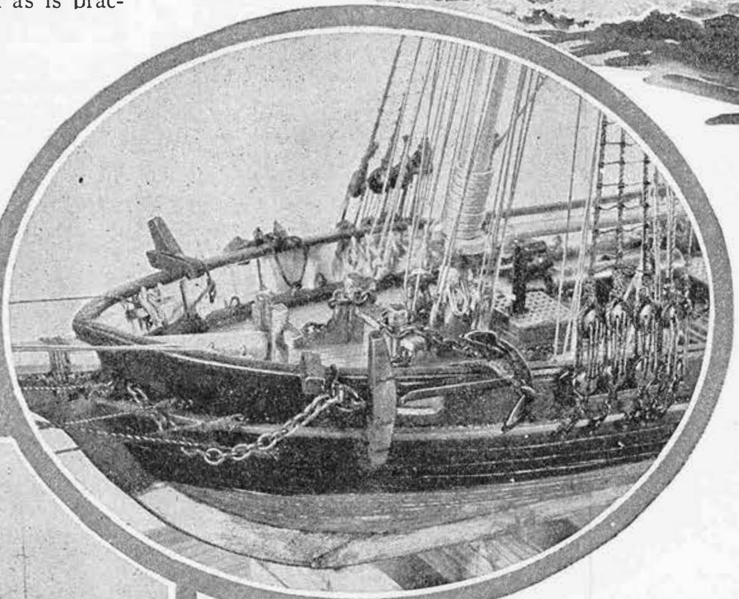
The boat davits, as shown in the deck plan and in two photographs, lie on the cap rail and continue the line of the sheer. They also have four holes in the ends for the boat-tackle falls.

Several holes are needed in the hull. There are holes each side for the anchor cables, called hawse holes. The position of these is shown on the deck plan. An oblong hole is made in the stem for the gammoning lashing to hold the bowsprit down. There is a hole in the counter for the rudderpost to pass through. This must be very carefully made. It is best not to complete it until you try out the rudder for size and position, although that shown should be right.

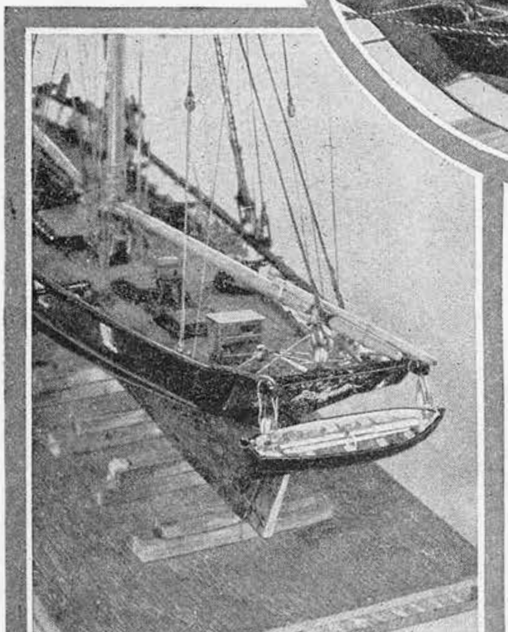
The rudder should now be fitted. Make it to the shape shown on the sheer plan. It is 3/32 in. thick and tapers slightly to the back, with its front edge and the edge of the sternpost slightly rounded so that it will swing. The rudder post is



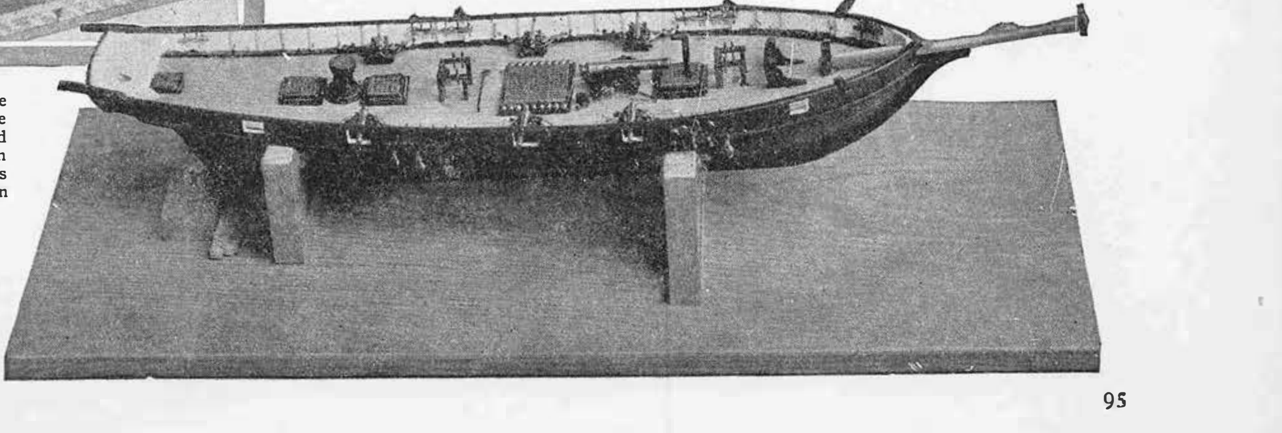
This ship was a 6-gun privateer used in the War of 1812. She was 92 ft. on deck, 24 ft. beam



Bow view showing various fittings mentioned in this article, including the catheads, bitts, channels, and pinrails



Four of the hatches, the capstan, the binnacle, the boat davits and boat, and several guns can be seen in this view, which shows the model from the stern



Hull with principal fittings in position. The hull itself is 13 in. long but the overall dimensions of the finished model are 20 in. long, 13½ in. high

KEY TO THE RIGGING

To save space the following abbreviations are used.

F	fore	T	top
hal.	halyards	TG	topgallant
M	main	TM	topmast
P	port	TS	topsail
S	starboard		

The parts are numbered as nearly as possible in the order of application to the model. Those printed in *italic type* should be applied to the last preceding regular number before the latter is installed on the model. The sizes of the cords and blocks are indicated by small letters following the name of the part. Cord *a* is equivalent to No. 20 (B. & S.) gauge wire; *b* to No. 24 wire; *c* to No. 26; *d* to No. 30 (although the *d* size may be used, if preferred, for both *c* and *d*) Blocks *f* are 3/16 in.; *g* 5/32; *h*, ⅛; *j*, 3/32.

1 F mast
2 M mast
3 Cheeks
4 Futtock band
5 Crosstrees
6 Cap
7 Eyebolts and bands
8 Hoops for sail
9 Boom-jaw ring
10 Mast coat
11 Bowsprit
12 Chocks
13 Bees
14 Shroud deadeyes
15 Cap
16 Gammoning
17 F stay a (double)
18 Hanks (wire rings)
19 M jumper stays a c f (P & S)
20 Lower shrouds, deadeyes, and lanyards a c
21 M stay a
22 F boom
23 F sheet c g
24 F boom topping lifts b c g (P & S)
25 F gaff
26 Throat hal b g
27 Peak hal c h
28 Vangs b c h
29 Throat downhaul c
30 M boom
31 Sheet b f
32 Topping lifts b c g (P & S)
33 M gaff
34 Throat hal b g
35 Peak hal c h
36 Vangs b c h
37 Throat downhaul d
38 Peak downhaul d
39 Bowsprit shrouds a c
40 Jib boom
41 Jib-sheet ring
42 Lashing c
43 Martingale boom
44 Boom guys
45 Martingale a
46 Backropes b (P & S)
47 Jib stay b
48 Hanks
49 Jib-stay outhaul d h and sister block
50 F topmast
51 FT shrouds b
52 FT stay b
53 FT backstays a
54 F TG stay c
55 F TG backstays c
56 F yard
57 Jackstays
58 Horses or foot-ropes (wire)
59 Stirrups (wire)
60 Studding-sail boom irons
61 Sling a c and bull's-eyes
62 Truss b
63 Topping lifts b c h
64 FT yards (with parts 57, 58, 59, 60, 62)
65 Chain tie
66 F TS hal a c g
67 Lifts b
68 TG yard (with parts 57, 58, 67)
69 TG hal c d
70 M topmast
71 Hoops
72 Shrouds b
73 M TM stay b
74 M TM backstays b
75 F braces b c h
76 F TS brace c h
77 F TG braces d h
78 Lower yard studding-sail boom
79 TS yard studding-sail boom
80 Staysail hal d
81 Staysail downhaul d
82 Jib hal d
83 Jib downhaul d
84 TS sheets b c g
85 TG sheets c h
86 TS clew lines c h
87 TG clew lines d j
88 TS buntlines e j
89 TG buntlines e j
90 F & M sheet ropes b
91 F & M brails e j
92 Gaff TS hal c h
93 Gaff TS sheet c j
94 Gaff TS downhaul e j
95 Gaff TS tack c
96 Staysail sheet c g
97 Jib sheet c g
98 Ringtail sheet

Note: Parts 80 to 98 are sail gear and may be omitted.

square, bending a little forward where it passes through the deck. The tiller, which is mortised into the rudder post 3/32 in. from the top is 1/16 in. thick, ⅛ in. wide, and 1 3/16 in. long. It is slightly curved and tapered toward the end and is set parallel to the deck and ¼ in. above it.

For a simple model, nail on the rudder with two-pointed nails, or nail right through. For a fine model, fit it with gudgeons and pintles. The gudgeons (sockets) are of strip brass, bent and soldered around a No. 20 escutcheon pin and the pin removed. The pintles are the same, but with the pin soldered in. By careful drilling, you can rivet the straps from side to side. The rudder must be fitted close to the sternpost or the post will not go through the counter. If necessary, reduce the width of the sternpost slightly.

Before making the deck fittings, take a strip of paper and from the deck plan mark the position of all parts, including the masts. Transfer these positions to the center line of the deck.

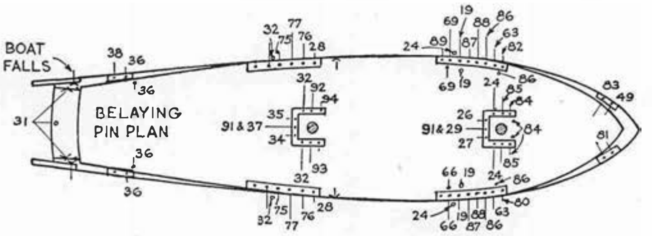
Forward are the cross bitts for holding the bowsprit in position. This is just a crossbar notched halfway into two uprights, which are driven into holes in the deck and there glued. As the bowsprit does not quite come to the deck, a little block is glued to the deck between the bitts.

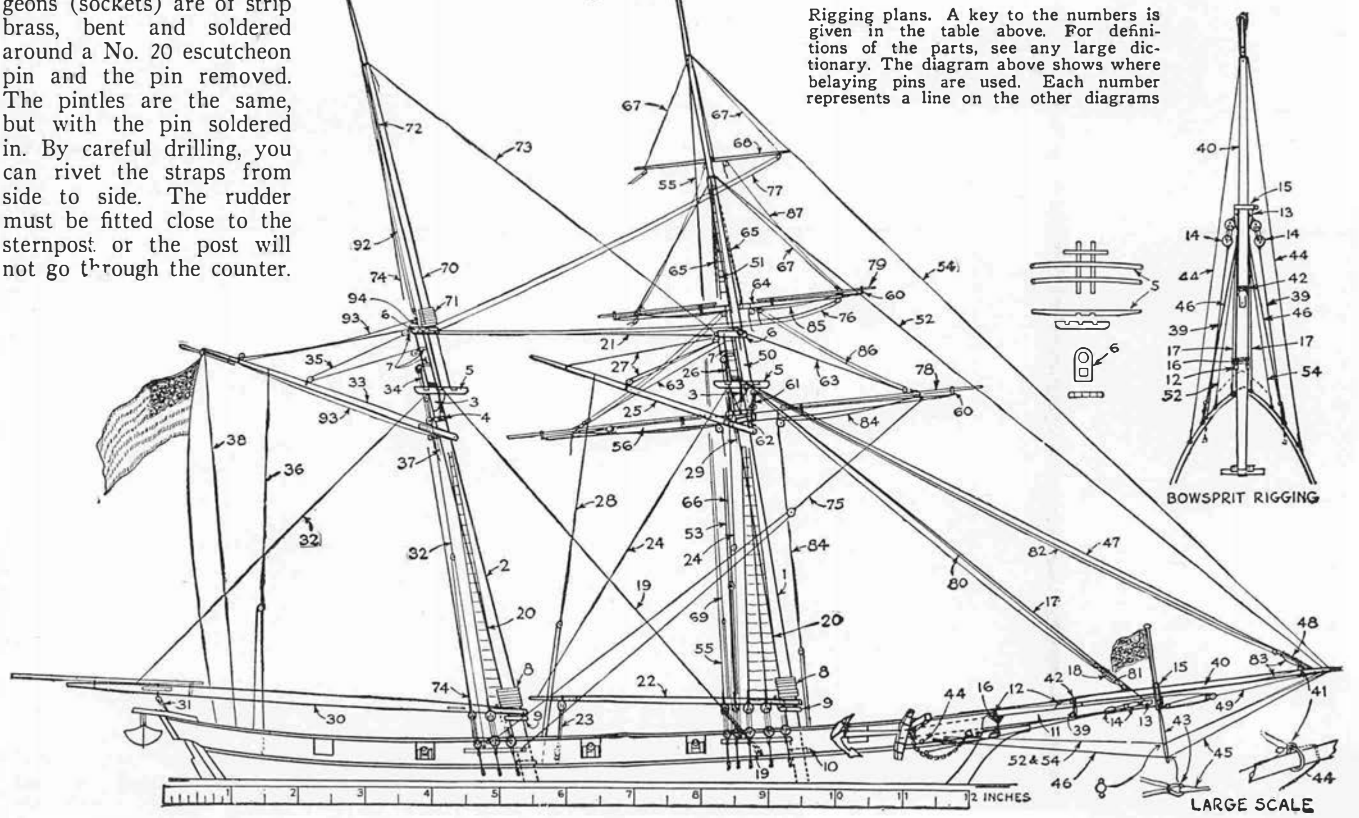
For this and other deck fittings, boxwood, holly, or any other wood of fine texture will do.

The cable bitts are similar to those described except in shape. They have knees on the fore side as shown in the plans and detail drawing. Stain them brown.

There are five hatches, all the same except in size. The coamings (sides) can be square pieces of wood, slightly hollowed to take half the thickness of the gratings, or they can be built of rabbeted pieces. They are painted black. The gratings are best made of boxwood, with the cross strips half-lapped to the others, but the indentations can be punched with a square point or merely drawn on.

It gives a better finish to put troughs around three of the hatches for the shot for the 6-pounder guns, and one on each side of the large hatch for the 24-lb. shot. They are merely rabbeted strips of a size to take the shot, with half projecting. The size of the small shot is 1/32 in. and the large, 1/16 in. Gunshot can be obtained in about these sizes, or steel





Rigging plans. A key to the numbers is given in the table above. For definitions of the parts, see any large dictionary. The diagram above shows where belaying pins are used. Each number represents a line on the other diagrams balls made for use in bearings may be bought in a bicycle repair shop.

The capstan can be turned or filed to its outside shape and then the spaces between the whelps (see detail) dug out with a tiny chisel, or the whole can be built up. The pawl channel is a separate piece cut all around to represent notches for the pawls. The latter are six pin points bent over and driven into the edge of the capstan. They are to prevent the capstan from slipping backwards. The capstan may be either brown or black.

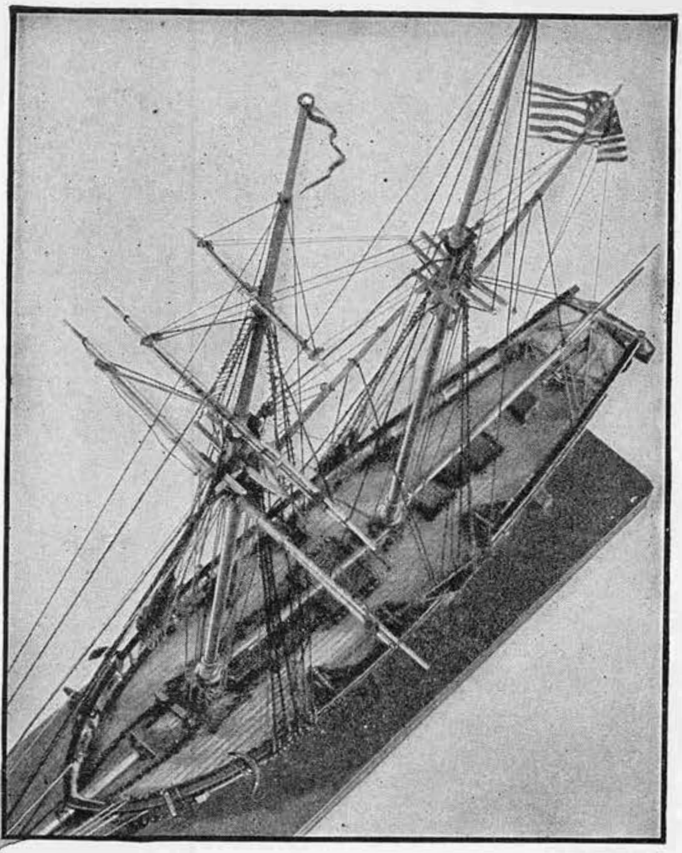
Bars are required to turn the capstan. These are in racks, three to a side, glued to the bulwarks, as shown. They are actually round bars about 7 ft. long with square butts to fit in the holes in the head of the capstan. Make them look like varnished wood.

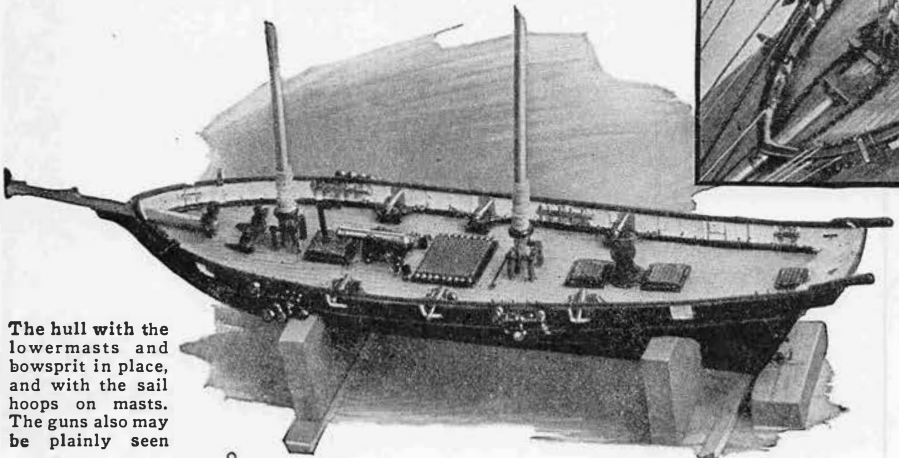
The model has a box-type binnacle. An upright teakwood cabinet, with a sliding door in the front—that is, the side facing abaft—shows a compass on one side and a lamp on the other.

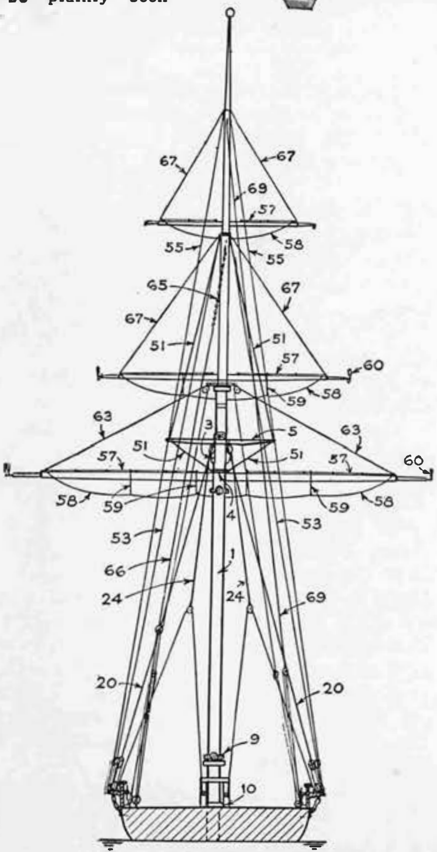
On this hangs the bell. The photographs do not show it because it was not added until later. It is ⅛ in. high and ⅛ in. across the mouth. It can be hung on a brass wire staple.

Cable pipes to lead the anchor chains below are short pieces of tube of a size to take the chain, set just forward of the main hatch.

There should be pumps on either side just abaft the mainmast, although these are not in the pictures either. They would probably be small hand pumps as shown clearly in one of the drawings. Pieces of tube will serve. The handles would be unshipped except when in use.


How masts and spars are set up. Note particularly the crosstrees and the position of yards


The hull with the lowermasts and bowsprit in place, and with the sail hoops on masts. The guns also may be plainly seen



FOREMAST LOOKING FORWARD

There are fife rails around both masts. Each has four posts with the toppieces half-lapped at the corners. The rails are drilled for belaying pins. The two forward posts need holes representing sheaves (wheels) for the boom-topping-lifts and gaff halyards to lead through. The forward posts at the foremast have one hole each for the topsail sheets. Do not fit these until you have bored for the masts and are sure that the latter will not touch them due to their rake aft.

Quite a number of bolts are required in the bulwarks, waterways, and deck. There is one in the waterways on each side of the gun ports, one in each timberhead beyond, four in the deck to hold the long 24-pounder down, and one in the stern for the mainsheet. There should also be one behind each gun to haul it in with, but these have been omitted.

The foresheet needs a traveler, which is just a piece of wire bent at right angles and with the points driven in the deck. Thread a little ring on it before fixing.

Then, of course, there's "Charlie Noble," the galley funnel, which projects through the forward hatch. It is just a piece of round stick on a miter, glued together, and painted black.

The bulwarks are pierced for ten guns, but it was a common custom not to carry the full equipment. The model has been given only six of the six-pounders and one long twenty-four-pounder, carried amidships. You may, of course, give her the full complement.

Materials for Rigging and Finishing

Cord: 15 ft. black, about as thick as 20-gauge (B. & S.) wire and designated throughout as size a; 20 ft. black, 24-gauge, marked b; 10 ft. black and 16 ft. white, 26-gauge, marked c; and 12 ft. white, 30-gauge, marked d. (If desired, the d-size may be used for both c and d.)

Wire: 2 ft. No. 32 magnet wire for footropes; 4 ft. No. 30 tinned wire for jackstays, etc.; 2 ft. No. 20 copper for chain plates, foresail traveler, etc.

Chain: 16 in. with from 11 to 13 links per inch for cables; 3½ in. with 17 or fewer links per inch for topsail halyards.

Blocks: 3/16 in., 3 single, 7 double, designated as size f; 5/32 in., 8 single, 6 double, size g; ⅛ in., 38 single, 3 double, size h; 3/32 in., 32 single, size j (for gun tackles); 1 sister block, marked hj; 1 bull's-eye, ⅛ in.

Deadeyes: 20 of 3/16 in., 12 of 5/32 in., and 4 of ⅛ in.

Tubing: 4 pc. 3/32 in. inside diameter and ¼ in. long for cable pipes and pumps.

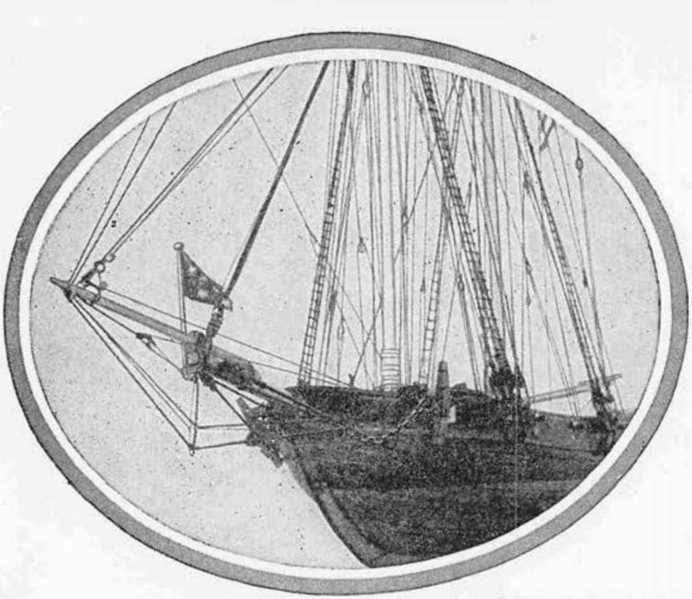
Pins: 60 common pins ½ in. long for making eyebolts, and additional for nailing and other uses; 20 No. 20 escutcheon pins for chain plates and rudder.

Anchors: 2 with wood stocks, 1 in. long.

Flags: 3 as described.

Miscellaneous: Black, white, and red paint; brown stain, varnish, glue, brads, etc.

The shape and size of these guns are shown in the detail drawings, and the positions are given on the deck plan. They are best turned from brass, but may be turned or filed from wood, or cast in



brass or lead. Brass guns should be oxidized; if of other materials, they should be painted black.

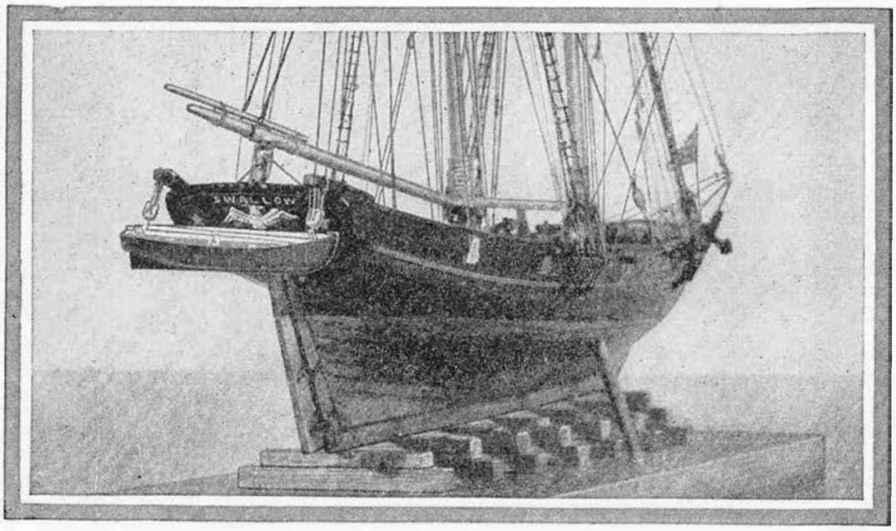
SIX-POUNDERS were from 6 to 8½ ft. long. You can make them to scale 7 ft. in length with a caliber (size of shot) of 3.7 in. Twenty-four-pounders were from 9 to 9½ ft. long, with a caliber of 5.8 in. The thickness at the breech is about three times the caliber, and at the muzzle, twice the caliber. The trunnions (crossbars) are placed at a point four-sevenths of the length from the muzzle.

The carriages are four pieces of wood glued together, with the wheels on wooden axles that go under the carriages. The front wheels are slightly larger to compensate for the camber of the deck. The wedge at the back is to lift the breech. The guns, when level, should point through about the middle of the gun port. Notches are filed for the trunnions, and the guns are held down with bent-pin staples, except the large gun, which should have a piece of metal nailed over for this purpose. Eyebolts are needed on the back steps for the tackles, and a ringbolt in the middle (at least on the large gun). They are all black. Simpler carriages may be made from an oblong stick with a groove in it to take the gun; and instead of wheels, round sticks may be used.

The guns are pulled up to the bulwarks with a tackle of two single blocks on each side. The blocks with wire hooks to go to the rings in the carriage and in the waterway. The ends are hitched around all parts. The breechings to take the recoil are of heavier cord. They run from the rings in the timberheads and are seized under the cascabels. They should be slack enough to allow the muzzle to come inside the bulwark, and by rights should go through the rings in the sides of the carriages.

The gear for the large gun is similar except that, instead of a breeching, there is a gun tackle, leading aft.

If these guns are glued down and a pin point driven through the back step or crossbar, they will remain in place.



Stern view showing the jolly boat and the type of base used on the original. The model is set on miniature graving-dock blocks and is shored on each side to take strain off keel

Now for the rigging. First we must make a set of spars. Any straight-grained wood will do, but carefully selected dowel sticks are the easiest to use. You will need about 24 in. of ¼-in. doweling, 36 in. of 3/16-in., 24 in. of ⅛-in. and four 1/16-in. applicators (swab sticks) about 6 in. long for the stuns'l (studding-sail) booms, flagstaff, and the capstan bars.

If the model is hollow, the lower masts must be long enough to reach the bottom of the hull, inside, where a double-pointed spike may be used to hold the heel in place. These masts taper very slightly and are square from the trestletrees up, with a smaller square at the top to set in the cap. The various fittings should be put on before the mast is shipped.

The crosstrees half-lap into the trestletrees, with one square opening to fit the lower masthead and the other to fit the topmast heel. Note that the holes in the boom supports and mast coats are at an angle, to lie horizontal.

The mast hoops for the fore- and mainsails, if used, can be made neatly over a stick the size of the mast, around which a piece of waxed paper has been wrapped twice. Make some thin shavings, wet them well with casein glue, and wrap them around the paper. When dry, sandpaper them and cut off sections with a sharp knife. There should also be some smaller ones on the main topmast for the gaff topsail.

The model has been made with enough running gear so that the sails can be readily bent, but all sail gear (items 80 to 98 in the list) may be omitted, because this gear would be stowed away if the vessel were to be in harbor for long.

The yard fittings are shown in detail. The jackstays are made from semihard, thin wire, and the staples from the same wire, bent double and hammered close after the rods are threaded on. The footropes (horses) and stirrups are made from covered magnet wire, stained black, because cord will not lie in place. The splices are just one twist of the wire. The stuns'l boom irons are made from pins hammered partly flat, bent into a circle, then at a right angle; and the ends are driven into the ends of the yards. All of these may be omitted from a simple model.

Topsail and topgallant yards are the same, except in the number of horses.

The lower yard is eight sided and is parallel for one quarter of each half. The others are round all the way along. The saddles of the upper yards have small eyebolts to take a lashing abaft the mast when the parts are assembled on the model.

Stuns'l booms are the same length as the yards, but cut into two. They are about one third as thick.

THE bowsprit is thickest where it comes out of the bulwarks. It has the end squared for a cap and has bees (cleats with holes) on either side for the two parts of the forestay to reeve through. On it is a notched cleat for the end of the jib boom to butt against, and two little cleats to prevent the gammoning from slipping.

The gaffs and booms are thickest one third from the masts. The ends are slightly flattened to take the jaws, which are glued and riveted through and have holes in the ends for a cord parrel. At the end there is a cleat on either side to keep the sheets in position but still enable them to turn. Outside of these is an eye on either side for the boom topping lifts. For these, bore a horizontal hole, pass the two ends of a bight of thin wire through, pass one end back, twist and cut the ends off. The eyes in the futtock bands and the deadeyes of the bowsprit shrouds can be made the same way.

The jib boom is thickest at the cap, has three holes for the stays, and a stop (step) for the martingale at the end.

The fore-topmast is octagonal as far as

the cap, then tapers very slightly to the head, where there is a little stop, thus reducing the thickness, and another similar stop at the topgallant masthead; these, of course, form one spar with the pole. It is bored across near the end for the fid, which is a bar lying across the trestletrees to prevent it from slipping down. It is also bored fore and aft near the topmast and topgallant mastheads for the yard halyards.

THE main topmast is similar, except that there is only one stop (that is, no topgallant mast). It is drilled for the fid and gaff topsail halyards. The other spars are for the ringtail (which may be omitted) and are like a stuns'l boom and yard.

The dolphin striker (martingale boom) hooks into an eye under the cap. It has a stop near the end and wire eyes on each side, one third up.

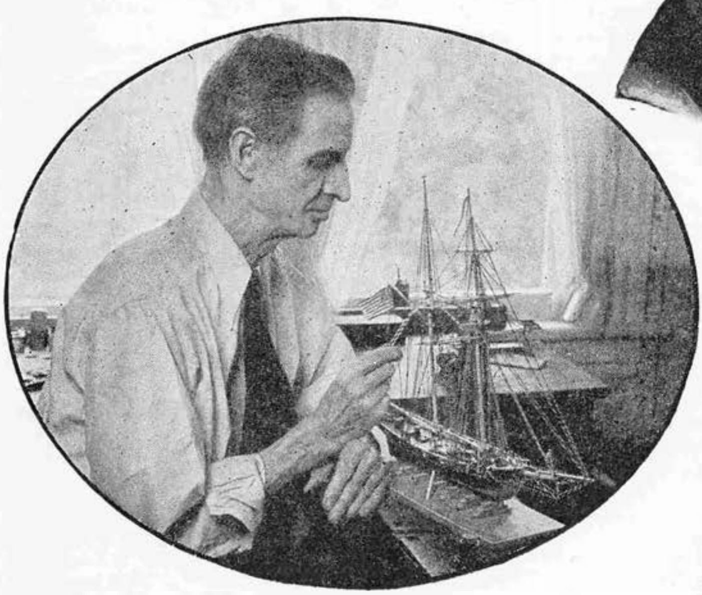
The three caps are best made from fiber board, but celluloid or box wood is almost as good. They should be a tight fit and keep the masts and jib boom parallel to the masts below, where they double.

You can finish all spars in a natural color, stain them a reddish brown and varnish them, or paint them white or black, except those sections of the masts where anything hoists. These and the jib boom are "bright."

This type of vessel was the fastest craft afloat at that time. Though very loftily sparred, they were small vessels, so the spars and cordage were lighter than that of a full-rigged ship. This should be kept in mind.

As with a real vessel, the first thing to be shipped is the bowsprit. The heel goes through the bulwarks, and the square end is set between the posts on deck. Pass the gammoning (lashing) around the 'sprit and through the hole in the stem about five turns, with cross turns between the 'sprit and the stem.

As there is no bobstay, the bowsprit shrouds come low on the hull (see the rigging plan). The after ends are spliced or seized to bolts in the hull. Deadeyes are turned into the outer ends, connecting with others fastened to the bowsprit at the after ends of the bees.



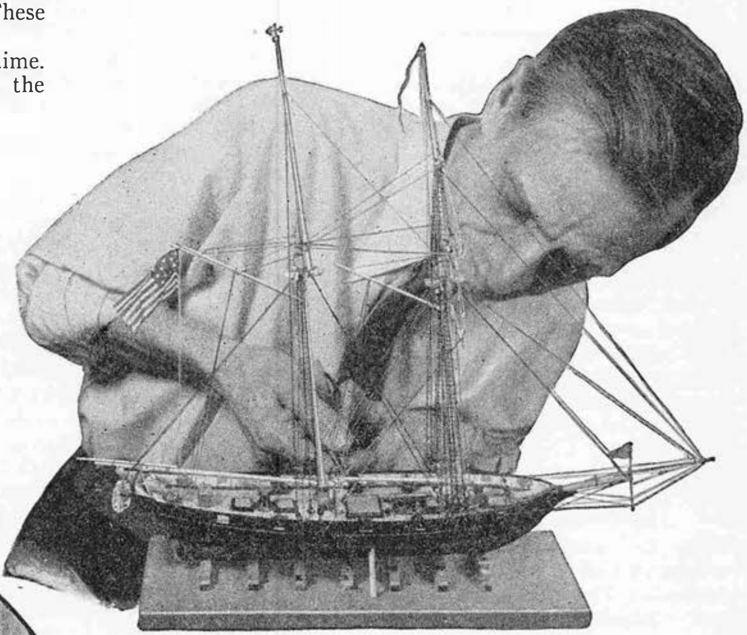
Four thicknesses of cord are required, as indicated in the accompanying list, although this may be reduced to three sizes by cutting out the size marked "c." For sail gear and seizings, use "A" sewing silk. Black cord will be required for standing rigging, and white or light brown for running rigging—that is, ropes which reeve through blocks. Where splices are mentioned, you can actually splice the thicker grades or seize the ends back (a seizing is a binding). With the thinner grades, a hitch is sufficient, as a rule.

To set up the rigging, deadeyes are used as shown in a detail drawing near the end of this article. Chain plates made like No. 1 are the most correct; No. 3 is the simplest, and No. 2 is the kind used as a compromise. It is formed of one ring around the deadeye, squeezed together underneath to lie in the notch in the channel. The bottom link is a link from a piece of chain, also squeezed together. The middle link is a piece of wire rove through both and soldered. The deadeyes must lie snug on the channels. A small escutcheon pin holds the lower end down.

Now ship the foremast, being careful that it is in line with the stem and at the right rake aft. For the shrouds take a piece of cord, seize a deadeye in one end, pass the other between the crosstrees, around the lowermast and down again on the starboard side, and seize in another deadeye. Put knots in the ends of pieces of c-cord, pass the ends through the hole in the top deadeyes (facing the left eye when looking outboard), through the corresponding lower deadeye, and so on. Haul them down tight together, but do not fasten. Do the same on the port side. When all four are tight with the mast upright and the deadeyes are at the same level, hitch the ends around the shroud above the deadeyes.

As there are three shrouds to a side, pass the last one up one side and down the other; or, better, make a cut splice and pass that over the masthead. Do the same at the main, but use only one pair each side.

The forestay goes over the forward crosstrees, around the lowermast, and down the other side. The ends go through the bees and are seized tightly to bolts in the hull, close to the bowsprit. If you are showing the hanks (rings) for the foresail, these go on before reeving through the bees. The two parts are seized together above the jib boom and at the top.



THE mainstay is spliced around the lowermast head, close under the cap, and is seized back to the eye in the forecap. The preventer stays go around the masthead as for the fore, but in the ends are spliced 3/16-in. blocks connected with similiar blocks strapped to bolts in the deck at the waterways. When the foresail is set, the lee preventer stay is slacked up.

The ratlines (steps) are of fine sewing silk, a full ⅛ in. apart, clove-hitched to each shroud. Use a bent needle for this, working from left to right.

Before shipping the booms, pass a knotted cord through one end of the jaws, splice in the topping lifts, and seize on the sheet blocks. The seizings pass through the slots in the cleats. Double 3/16-in. blocks are used for the upper, and single for the lower. Put the jaws to the masts, pass the ends of the cords through the other holes in the jaws, and knot them. Reeve the topping lifts through blocks seized under the trestletrees and splice blocks in their ends; through these reeve thin cords, one end of which goes to the bolts in the channels and the other through the outer sheaves in the fife-rail posts.

The fore-sheet block hooks to the ring on the traveler and hitches around its own parts. The main sheet hooks to the ring in the taffrail, each end belaying to a cleat in the knees at the corners.

The foregaff has a double block at the jaws and another to

TABLE SHOWING LENGTH AND GREATEST DIAMETER OF SPARS

	Fore	Main
Lowermasts (from decks)	6-5/16 x 3/16	6⅝ x 3/16
Topmasts	6½ x ⅛	6⅜ x ⅛
Bowsprit	4-1/16 x 3/16	
Jib boom	4-3/16 x ⅛ (scant)	
Martingale boom	13/16 x 1/16	
Lower yard	6 x ⅛	
Studding-sail booms (lower)	3 x 1/16	
Topsail yard	3⅛ x 3/32	
Studding-sail booms (topsail)	1¾ x 1/32	
Topgallant yard	2⅜ x 1/16	
Booms	3¾ x ⅛	6½ x 3/16
Gaffs	3⅛ x ⅛	3⅝ x ⅛
Crosstrees	1¾ x 13/16	1¾ x 13/16
Square mastheads	⅞ x ⅛	1 x ⅛
Total height of masts from deck	12	12
Total length of bowsprit and jib boom	6¾	

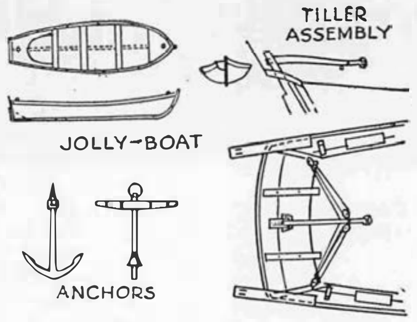
the eye on the mast. The tackle of b-cord reeves through these and down through the inner sheave in the fife rail, to port. The peak halyard starts at the end of the gaff, through a double block at the masthead, through a block halfway out, then up, and down to the fife rail to starboard.

THE main is the same except that the peak halyards have two blocks on both gaff and mast, and the sides are reversed. Both have vangs to steady them from swinging. These are spliced or seized around the gaff and lead with a single block and runner to bolts in the waterways. Throat downhauls are needed to keep them in position—from jaws to fife rails. They should each have peak downhauls also.

The jib boom reeves through the cap and has its heel lashed on the cleat on the bowsprit. The martingale boom, commonly called the dolphin striker, hooks to an eye under the cap, has an eye on either side for stays to reeve through, and a shoulder at the end. For the martingale and backropes to hold it in position, splice a single cord (a) into the bight of another cord (b), with the eye of the latter just big enough to go on the end of the dolphin striker. Put this on, take the single cord and seize it around the end of the jib boom very tightly, then draw each leg of the backropes back to eyes in the hull and seize; or, better, make eyes in their ends and tighten with lanyards.

The ring for the jib stay must go on the boom before the martingale. This is a ring to slide on the jib boom, with a smaller ring soldered above it. The jib stay splices around the masthead, reeves through the little ring just mentioned, through a hole in the jib boom, and has a sister block turned into its end. This is connected with a single block hooked to an eye in the cap (underneath), the end coming inboard to one of the forward belaying pins. This may be omitted and the stay lead without the ring through the jib boom and through an eye in the martingale boom.

The fore-topmast may go on next. Don't forget the fid, or piece of wire through the heel to prevent its slipping down. Here the stays go on first, splicing around the mastheads and leading through holes in the jib boom, through eyes on the dolphin striker, and back to bolts in the bull where the ends are seized back.



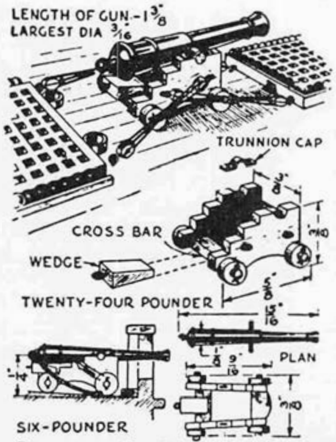
The 2-in. long jolly boat, the 1-in. long anchors, and method of rigging the tiller

Next, the topmast shrouds, one pair each side, are seized to the masthead. They lead through holes in the ends of the crosstrees and are seized to the eyes in the futtock-shroud bands. These should have ratlines.

The topmast and topgallant backstays come down as the lower shrouds to their respective deadeyes—5/32 in. for the topmast and ⅛ in. for the topgallant backstays.

The main topmast is similar, except that there is a long topmast, no topgallant mast, and only one shroud and one backstay to a side. If you are using hoops, there must be some on this mast for the gaff topsail. The stay goes from the masthead to a bolt abaft the main cap.

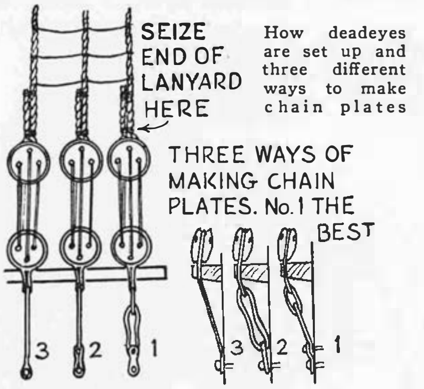
The lower yard is suspended with a sling and held to the mast with a truss. The former is a long strap with a bull's-eye seized in the bight. This is then passed around the mast and through the other bight, to lie close above the yard. An eye is seized in the bight of another cord with a long end to go over the cap. It is passed through an eye spliced in the short end and seized. The bight of this and the bull's-eye are drawn together with a lanyard so that the yard lies immediately below the futtock band when drawn to the mast with the truss. This is of a-cord with a short end having an eye and a long end that goes around the yard and mast. The end leads on deck to draw the yard close to the mast or slack it, as required. These fittings may be much simplified if desired.



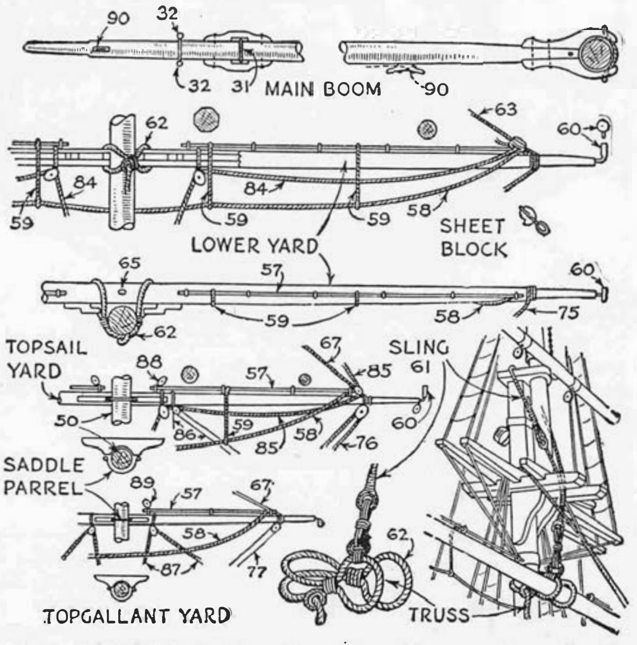
Large gun in place, its carriage, and details of the six-pounders

AT the yardarms the brace pennants are spliced on first, then the topsail-sheet blocks if any, then the topping lifts. A neater alternative is to splice the sheet blocks into the lifts. The forebraces have long pennants with single blocks, the whip of which fastens to the eye in the end of the channel, and the hauling part goes through a block strapped to the other eye, then in to the pinrails. The topping lifts are single, passing through blocks seized to the spreader at the masthead. The ends have single blocks and whips to the deck and pinrails. The stunsail booms can now be rove through their irons to extend a little beyond and have their inner ends lashed to the yards.

The topsail yard is held to the mast with a lashing through two eyebolts in the saddle and is raised with a chain tie passing through a hole at the masthead and down abaft to a double block, with another in the waterways on the port side, so that the end comes up to the pinrail. At the yardarms, brace blocks are strapped on first. The ends of the braces are seized to the eye of the mainstay, lead through the yardarm blocks, back through double blocks strapped to eyes at the sides of the main cap, and to the pinrail. The lifts are single, spliced to the yardarms, and seized to the


SEIZE END OF LANYARD HERE
THREE WAYS OF MAKING CHAIN PLATES. No. 1 THE BEST
3
2
1
3
2
1

How deadeyes are set up and three different ways to make chain plates



Details of main boom; side and top views of lower yard; topsail and topgallant yards; perspective sketch of crosstrees, yards, and truss eyes of the rigging. Sheet blocks are used as before.

The topgallant yard has a similar parrel to the topsail yard. The halyard is a rope from an eye in the yard, through a hole in the masthead, and down on the starboard side to a single and a double block. The lifts and braces are as before.

The model has been given such sail gear as would be left rove off during a short stay in port. The topsail sheets start with an eye splice, reeve through the yardarm blocks mentioned, along under the yard through blocks strapped to them amidships, and down with single blocks and whips to eyes in the deck, the end going through the forward posts of the fiferail. The clew lines start at the heel of blocks strapped under the topsail yard, through hook blocks hooked to the sheets, back through the upper block, and to the pinrail. The topgallant gear is similar, except that the clew lines are single. Two buntline blocks can be seized to the topsail-yard jackstays, and one to the topgallant.

The staysail and jib halyards have their ends seized to the eye of the forestay, lead through blocks hooked to the top hank, and back to blocks seized under the crosstrees—staysail to starboard and jib to port. The downhauls hitch to these blocks and lead through blocks seized to the stay at the jib boom and in to the forward pinrails.

The gaff-topsail gear consists of a halyard, the end of which is seized to the eyes of the rigging, goes through a hook block, back through a hole in the masthead, and to the deck. The downhaul hitches to this block and leads through a small block at the cap to the deck. The sheet also hitches to the block, leads through a hole in the gaff end, through a block under the gaff, and to the deck.

The ringtail, if used, is set like a stunsail. The yard hoists on the peak downhaul to the peak, and the boom lashes to the main boom, or has an iron like the other stunsails.

Coils of rope on the belaying pins give a good finishing touch. These should, of course, be the actual ends of the ropes, but it is easier and neater to belay the ropes by taking a turn under the pin, then throwing a hitch (with the tweezers) over the pin, and cutting short. Then make coils of the same size rope on a stick, tie them with one turn of silk, and glue them in position.

Two wood-stock anchors about 1 in. long are needed, with chain cables of about eleven links to the inch. The rings of these are hung to the catheads with the stoppers. Cords, with a knot, go through the catheads, through the ring, and fasten inboard to a cleat or ring in a timberhead. The flukes are held level with the rail by the shank painters—cords or chains around the crowns, fastened to bolts in the waterways.

The cables lead through the hawse pipes along the deck, under the ends of the cable bitts, over the uprights, under the ends, and along the deck to the chain pipes. The stoppers are short ropes with a big knot in the ends, seized to bolts in the deck. The chains are lashed to these to hold them back.

This vessel should have several boats, but they clutter up the deck so much that it is more practical to give her only the jolly-boat under the stern. It is 2 in. long and ⅝ in. in beam, and is hung with a double block hooked at each end, the fall being rove through these and the sheaves in the stern davits and belayed to cleats or to the pinrails. To make her hang properly, suspend a weight from the boat and then dope the falls until stiff.

The tiller ropes start from a bolt at the side, through a block seized to the tiller, back to a bolt at the side, through a ring under the tiller, and the same on the other side, thus forming an endless tackle.

These vessels were not entitled to pennants, but usually flew them, so make a red and white one. The ensign of the 1812 period has thirteen stars and thirteen bars. These hoist on halyards of thin silk.

The trucks are little balls. Bore them first, then shape them with a file, and apply gold leaf. You can add a small weathervane arrow at the main if you like. A jack can be flown on a short staff at the bowsprit cap. This is stepped in two little staples at the side of the cap.

The base can be any of the approved forms. The photographs show graving-dock blocks. Screws are driven through two of these, up through the keel and into the hull. The blocks are then screwed to the baseboard, which is 4½ by 13 in. The other blocks are merely fitted in place and glued. A shore will be needed on either side to take the strain off the keel. Bore right through the base, at an angle, then push them up and toenail them.

Remember that the water line must be horizontal; that is, the keel will be 5/16 in. higher at line III than at line XI.

This completes our little *Swallow* model.

HOW TO TEST ALIGNMENT OF A YACHT MODEL

IN THE construction of a model racing yacht, here is a practical and simple method for determining the alignment of hull, keel, and skeg. It will prevent inaccuracy in any of these parts, which would seriously affect the sailing efficiency of the finished craft.

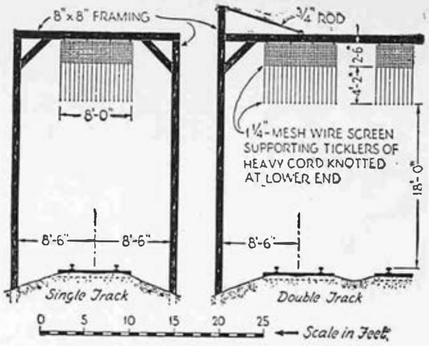
The model is turned upside down and carefully leveled on a table. Two posts are erected at opposite ends of the table top, and a line is strung between them. A plumb line, suspended from a brass hook, can then be dropped anywhere along the boat. The preliminary step is to drop the plumb at both the stem and the stern so that the hull can be perfecly centered under the line. Even minor errors can be detected by sighting along the length of the boat.

The hull might also be placed in a horizontal position on a wall and a plumb line dropped square from the stem but clear of the keel, and sighted for alignment.

A counterbalanced traveler can be swung on the line, and plumb lines dropped to different points on the hull. By reversing the carriage, equidistant points on the opposite side of the hull can be spotted for high or low points.

SMOOTHING SMALL CARVINGS

WHEN model parts are hand carved and afterwards painted, a good trick is to coat the surfaces with waterproof casein glue. When this is dry, it can be sanded down to a smooth, even finish that covers all carving marks.



MINIATURE TELLTALES FOR MODEL RAILWAY

FOR the model railway system that boasts a tunnel or any other overhead obstruction, it is desirable to supply miniature telltales. Rules and regulations demand that telltales to warn brakemen atop freight trains be provided at all places where the clearance is less than 21 ft. (in some states, 22 ft.). Look over your system and see if this safety feature has been neglected.

The drawing above shows telltales for both single and double track layouts. If your road is built to a scale of ¼ in. to the foot, the framing for either the single or double track telltale should be made of slender strips of wood. For the smaller scales, use square wire (bus bar, found in old radio sets, is ideal) and make the framing all in one piece with the corner braces soldered in place.

The wire screening that supports the ticklers should be made of some open weave cloth. Cross-stitch canvas, a stiff, lightweight cloth, is suitable. A piece somewhat larger than the required screen should be painted or stained black and then cut to size. The lower edge of the cloth is frayed out and every fourth or fifth thread left longer than the rest to represent the ticklers. Paint the frame a dark brown to look like creosote.

Place the telltales not less than 100 ft. (to scale) from the tunnel or bridge it protects. The ticklers should extend at least 6 in. below the obstruction.

Full-size dimensions are shown on the drawing, also a scale in feet so that the telltales may be reduced to any desired scale in order to meet the requirements of any model railroader, whether he works in O gauge, OO, or HO.

KINDLING CAMP FIRES

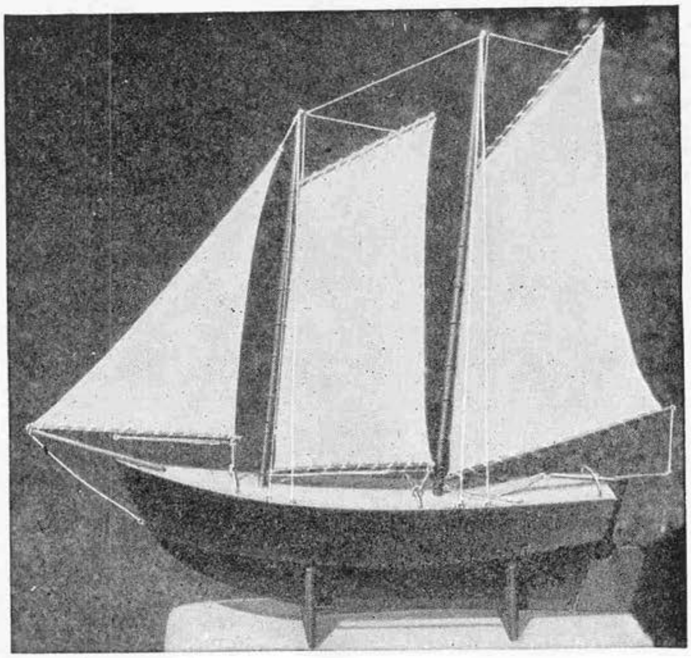
While camping, particularly during wet weather, it is often convenient to have material at hand with which a fire can readily be kindled. Sawdust saturated with kerosene and kept in a covered jar or tin is satisfactory for this purpose. Several spoonfuls of it will enable one to dispense with kindling if the wood is dry, and a somewhat larger quantity will ignite wood which is damp. In lieu of sawdust, wood ashes may be used.

• • •

A high-grade paintbrush on which you do not care to use a caustic brush cleaner can be soaked in amyl acetate ("banana oil"), washed well in alcohol, and combed with a stiff wire brush to remove every trace of scum.

A SPEEDY Racing Schooner

SIMPLIFIED FOR BOYS TO BUILD



A stiff, fast sailer, this schooner holds her own well with ordinary racing yachts up to 30 in. long. Her hull is only 24 in. long but is of such a design that she stands up and keeps steadily on her course in a way that always surprises the onlookers

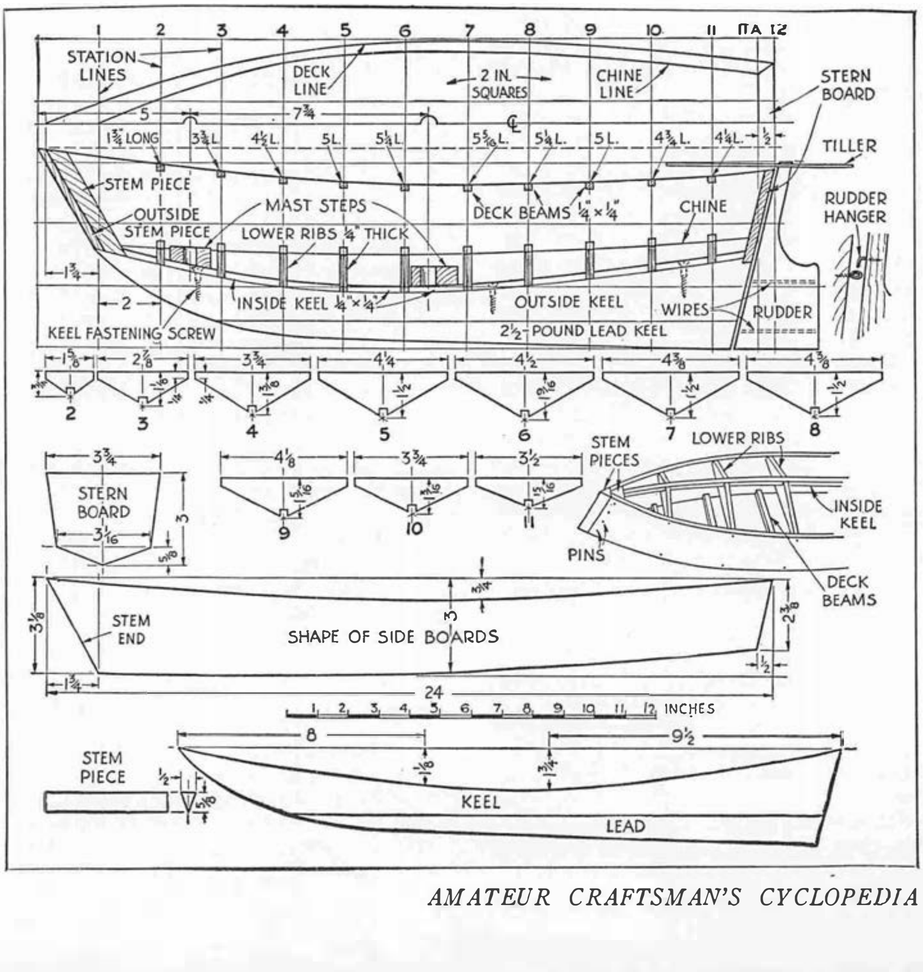
WHEN building miniature boats, some of us prefer sailing rather than shelf models. A special fascination attaches itself to sailing models that are planked or built-up instead of being dug out or made on the "bread and butter" plan. The construction has been so simplified that ten- or twelve-year-old boys can undertake the model, which is designed to develop skill to the point where it is possible to produce complicated operating models of modern steamers, yachts, or sailboats, true in form and line, pleasing to the eye, and efficient in the water. Very few tools are required.

The little schooner illustrated is an excellent beginner's model. It is not a copy of any existing boat, nor is it intended as such. The rig is similar to certain river schooners of years ago. After you have built this boat, you may, by using certain modifications of the lines and a few added tricks of construction, improve your craftsmanship to the point where it is possible to build any hull desired.

In spite of her very elementary characteristics, this schooner is a stiff, fast sailer. The simplified rig makes for speed in sail adjustments. In races with boats under 30 in., she will place frequently if handled reasonably well.

All of the material can be bought for about a dollar, or less if you find some egg boxes with thin sides that can be used. The best wood, though, is soft white pine.

This boat is built with glue. About the best kind to use is celluloid cement, and if you use much of it, it will pay to make your own. Place about ½ lb. of old celluloid side curtain lights from old cars, photographic films from which the emulsion has been removed, or even old celluloid toys and tooth-brush handles into a quart bottle with a wide mouth and fill the bottle with acetone. It is allowed to remain an hour, then stirred vigorously for about five minutes and corked tightly. The next day it is stirred until evenly mixed. It should have the consistency of thick cream. If you use this type of cement, do



not place it close to a flame or it will burn. It will dry very slowly if some white shellac is added.

For tools you need a coping saw or jig saw, a small plane, a very stout razor-blade knife, a sharp pocketknife, a fine-tooth hand saw or cabinetmaker's miter saw, a pin drill and drills No. 50, 55, 60, and 65, a light hammer of about 2 oz., sandpaper, a screw driver, and a few ½-in. No. 4 roundhead wood screws and washers. A jeweler's saw frame and blades are useful, as are round-nose pliers and a hand drill.

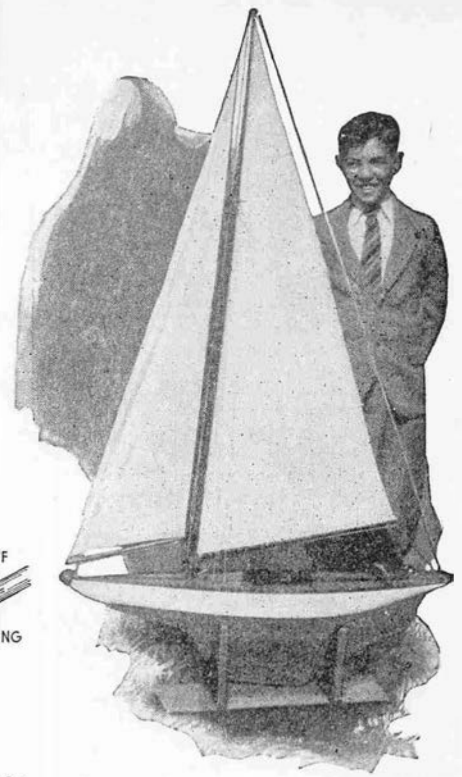
ON one ⅛-in. board (see list of materials) lay out a sidepiece. Tack this board to another and saw out both at once. Separate them and mark vertical lines 2 in. apart on both, beginning at the stern. These are the station lines for the lower ribs and deck beams. Plane the ½ by ⅝ by 10 in. piece to a triangular shape of the dimensions shown for the stem piece. Cut it into two 5-in. pieces.

Drive two 8-penny nails into a board on the bench till rigid; have them about 4 in. apart. Lay one of the 5-in. pieces with the back or ½-in. side against the two nails. Apply glue to the front end of one of the sides and nail it to the stem piece with ½-in. No. 20 brass escutcheon pins, as shown. Next lay this side flat in the jig, and nail and glue on the other side board. See that the stem is vertical. Now set this aside to dry while cutting out the lower ribs as shown. Cut a notch in each ¼ in. square for the keel. Cut out the stern board, too, but do not notch it.

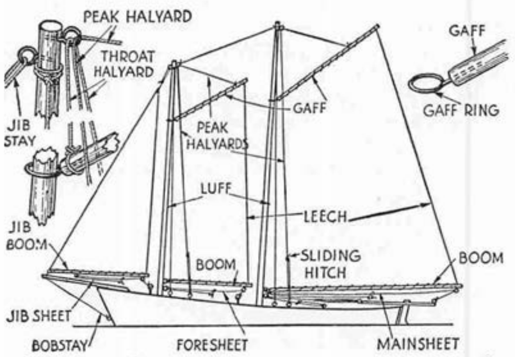
The keel is now cut from the ½-in. board. Plane the front edge to a point. Saw off the part which is to be replaced later with lead. This piece may be used as a pattern to mold the lead keel.

After an hour and a half, if you have used celluloid cement, you are ready to proceed. Hold the stern board in a vise, put glue on one edge of it, and nail one side-piece to it. Turn it over in the vise and glue and nail the other side. Use plenty of cement.

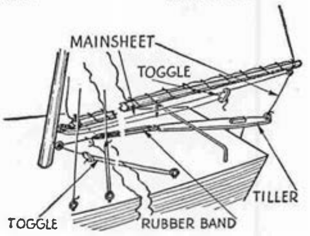
Spring the sides apart and slip the lower ribs into place at their proper stations. Set the ribs in so that the bevel begins at the edge of the side. Drive an escutcheon pin into each rib from each side. Make the inside keel from ¼-in. square wood. Fit it inside the inside stem in the notches of the lower ribs, and spring it over to, and inside of, the stern, as shown. Hold in place with glue and pins.



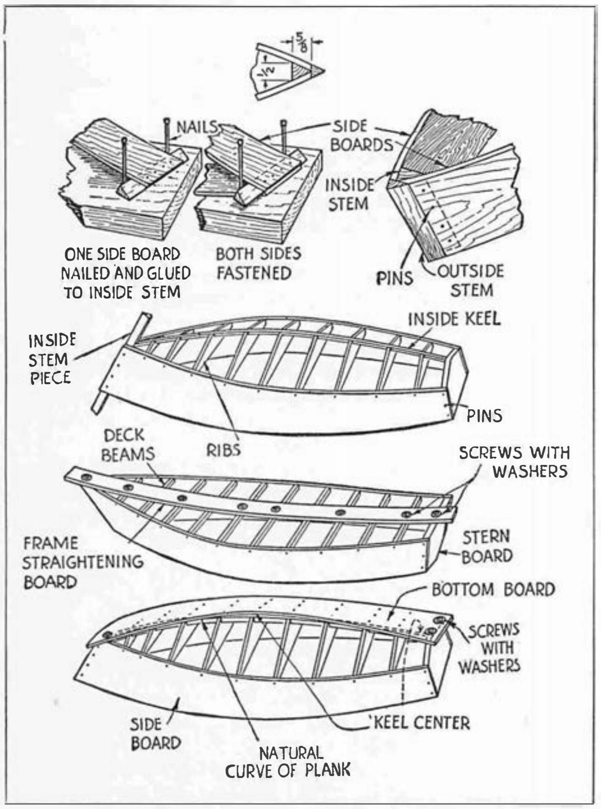
Once the method of construction has been mastered, a boy can construct as large and ornate yachts as he pleases



Foremast 18 in. above deck, 4¾ from bow. Mainmast—22 and 12½. Foresail—luff 13, leech 16¼, boom 6½, gaff 6¼. Mainsail — luff 15, leech 21⅝, boom 15, gaff 10. Jib boom—7½. Bowsprit—6½



The rigging plan. Both masts rake backward ½ in. The bowsprit overhangs the bow 4 in.



Steps in constructing the hull. The side planks are fastened at stem and stern board, and the ribs are then sprung in place

Turn the frame over and put in the deck beams. They are cut according to the lengths given on the plan from ¼-in. square stock. Mark a center line on each. Force each beam into place and hold with glue and a pin at each end. When completed, smooth the top of the inside stem flush with the sides.

Take one of the 2-in. pieces of ⅛-in. stock, mark a center line on it, and screw to the deck beams with screws with washers under them so that the center line of the boat, as indicated on the deck beams, and the center line on the deck board coincide. Use only enough screws to hold the hull straight. Do not glue.

Place the hull on the bench bottom up. Smooth off the inside stem flush with the end of the keel. Spring a ⅛-in board to one side of the bottom to get the feel of the bend. You will notice that it curves at the keel and will have to be cut on a curve. Mark around the outside of the hull while the board is held in place. Trim this board until about ¼ in. wider than the line shows. Put plenty of glue on the ribs, edges of the sides, and at the keel. Hold the board at the stern with ½-in. screws with washers under them and at the ribs with pins driven through. At the bow, screws will be needed. When in place, trim the bottom board along the center of the keel. Fit on the other side of the bottom as before, trimming the two sides together at the keel. This task requires more care than any other in building the boat.

PAINT the inside of the boat at the corners, ribs, and keel liberally with the cement. Now make mast steps and insert them in their proper places. Square off the front end of the boat and glue on the other 5 in. of the stem piece. Hold in place with a pin or two while the glue is drying.

The masts are made from ½-in. square stock, planed to a square taper of ¼ in. at the top and 7/16 in. at the bottom. Plane off the corners until eight-sided. Next, plane off these corners, one shaving at a time, while rotating the mast, and continue until it is practically round. The masts should taper from 7/16 to 3/16 in. The mainmast is about 26 in. long, and the foremast about 22 in.

Make the spars similarly. The main

List of Materials

No. of Pieces	Description	T.	W.	L.
4	Sides and bottom	⅛	3¼	24
1	Lower ribs	¼	3½	24
	Inside keel and deck beams	¼	¼	70
2	Spars	½	½	30
2	Spars	⅜	⅜	24
1	Keel	½	3½	24
1	Inside and outside stem	½	⅝	10
3	Deck	⅛	2	24

30 small galvanized screw eyes..

2 small screw hooks.

19 small brass curtain rings for mast rings.

1 paper brass pins.

½ oz. ½-in. No. 20 brass escutcheon pins.

Screws for keel and bowsprit.

White fishline about No. 3 cord size for rigging.

About 1 ft. No. 20 bare copper or brass wire.

2 bicycle spokes or brass rod of same size for travelers.

NOTE: All dimensions are given in inches.

boom and fore boom taper from about 5/16 to ⅛ in., and jib boom and gaffs are slightly smaller. Finish these with coarse sandpaper and smooth with fine. They are given three coats of spar varnish, polished with steel wool between coats. Finally rub them with steel wool, and polish with a good floor wax. The bowsprit is 6½ in. long, tapering from ⅜ to ¼ in. The part that is to lie on the deck is planed flat on that side.

BY the time the spars are made, the glue on the hull should be dry. Remove all pins and screws. Whittle pegs, dip in glue, drive them in the screw holes, and break them off. Sandpaper the bottom smooth, including the bottom of the outside stem piece. Fit the keel. Remove the center deck board and drill holes through the inside keel for screws. Fasten the outside keel in place with glue and screws from the inside. Replace the center deck board with glue. Mark and cut the mast holes, fitting the masts in place. Cut off the tops so that the foremast is exactly 18 in. above the deck, and the mainmast 22 in. Take out the masts and glue on the rest of the deck with plenty of cement. Hold temporarily with pins. With a sharp knife trim off the edges of the bottom, and smooth up. Fill any cracks around the keel with wood putty composition or with some wood dust mixed with cement and acetone.

Trim the sides of the deck and the outside stem, and sandpaper the completed hull smooth. Cut the rudder out of ¼-in. wood; bore two small holes clear through and drive in brads. File the brad ends off, and the rudder is reenforced so that it cannot split.

AS a pattern for casting the keel, use the piece of ½-in. wood cut off for this purpose. The keel may be cast in sand, or a mold may be formed by tacking two pieces of wood to a ½-in. strip so that they come above the edge exactly even with the pattern of the lead keel. Tack a block in the back end, and at the front put in a lump of plastic wood. After oiling the pattern, push it into this boxlike mold; then remove it. This shapes the wood putty to match the front of the keel. At places where screws will be needed, drive into the form 10-penny wire nails that have been smoked in a candle flame until very sooty. Drive deep enough to stand alone. Place the form in the vise, leveling the top edge. Pour it full of molten lead, being careful not to spill any or a bad burn may result. When cool, remove from the form and work the nails out. The keel should weigh about 3 lb. If more than that, file off some. Screw the lead to the bottom of the keel, fill any cracks with wood putty, and paint the hull.

THE jib boom is fastened to the bowsprit with two screw eyes. One is screwed into the bowsprit; the other is opened, hooked into the first, closed up, and screwed into the jib boom. Always bore a hole in spars before putting in a screw eye. The same procedure holds for the fore and main booms. The gaffs are rigged by drilling two holes and lacing in a piece of No. 20 wire to make a ring on the end. The end is then wrapped with thread, which is glued to hold it securely.

The tiller is made from wood ¼ by ½ by 6 in., tapered as shown. Two inches from one end a slot is cut for the rudder, which is held in place by two brass pins passing through the tiller and rudder. The ends are cut off, a daub of glue applied, and a screw eye put in each end.

Make a cradle for the boat and set her in it. Put on the bowsprit with two screws and glue. Insert the masts and drop seven rings on the foremast and nine on the mainmast. Put on the gaffs. Screw eyes are inserted in the tops of the masts. Wrap the tops with thread and apply glue. Put the screw eyes in the booms as shown, and two screw eyes in the deck on each side of each mast, the first ½ in. back of the mast at the deck and the second 2 in. back of the mast. At the bow about ½ in. above the keel insert another last screw eye. Rig the ship with No. 3 cord from the bow screw eye, up over the end of the bowsprit to the top of the foremast and across to the mainmast. Make sure the masts are still as far apart at the top as at the deck. Tie in the side stays on the foremast first, then on the main.

Cut the sails from light cloth. To avoid trouble here, proceed as follows: A piece of wrapping paper is cut ⅛ in. oversize one way. The cloth is cut to this pattern ¼ in. oversize all around. Use the selvage edge at the leech (after edge). The pattern is then sewed to the cloth, except the selvage side. The overlapping edge is folded over the paper, and the sail goes through the sewing machine again. Make one more fold, this time turning over the edge of the paper, and run the sail through the machine twice around three sides. Tear away the paper, and a sail with a neatly hemmed edge on three sides is left. This prevents any distortion of shape by hemming.

The sails are fastened to their respective spars at their corners and pulled tight, then held in between with a simple lacing from tip to tip. When fast to boom and gaff, the hoist lines are tied in. Then the mast rings are sewed on.

The three travelers are sections of bicycle spokes or brass rod of the same size, bent as shown to fit the deck. They extend to within ¼ in. of each side. A ring is put on two of them, and they are driven into the deck over a deck beam. The third or after traveler has no ring and goes over the tiller. Hang the rudder on two pintles, one at top and one at bottom, as shown.

The sheet lines and rudder rigs now go on. A line is tied to the outboard end of the tiller, passed through a screw eye in the end of the boom, thence through a toggle, thence through the screw eye in the other end of the boom that is locked into the eye in the mast, back through the toggle, and tied. These toggles are made of pieces of toothbrush handles cut with a hack saw to approximately 1/16 by ⅛ by ½ in. Two holes are drilled with a pin drill the size of the cords. When moved backward or forward, the toggles hold the sheet wherever it is set.

The other booms are controlled in a similar way except that the sheet line is tied to the traveler ring.

The arrangement of the rudder tension is illustrated. There is a screw eye in the mainmast and another in the deck; and a line from an elastic band is toggled here so that the tension may be adjusted by the toggle. When the wind hits the mainsail, the rudder is pulled to steer the boat away from the wind instead of letting her jump into the wind. Adjustment of the tiller tension will give you the right control of the boat.

You can learn much about sailing with a rig like this if you will stake out three buoys on a small pond and then try to sail this boat around the course. In fact, with three or four boats you can run real races since you can follow around the edge of the pond and readjust the sails each time the boat touches, thereby continuing the circuit of the course. Thus you get experience in sailing in all directions regardless of the wind.

PHOTO COLORS DYE WOOD FOR SPECIAL INLAYS

WHEN a rare wood of some special color is required for inlay purposes, but cannot readily be obtained without considerable trouble and delay, white woods of a similar grain structure can be easily dyed to resemble it reasonably well.

As a source of dye, you can make use of the transparent water-color stamps sold in booklet form for coloring photographic prints. These booklets are inexpensive, contain twelve different colors, and can be bought at any photo supply house. Dissolve portions of the dye-coated sheets in alcohol to match the color desired. Immerse the wood in the dye solution for a length of time depending upon the penetration desired. The wood when dried is ready to use.

Novel effects may be produced in some woods by incomplete dyeing. When the veneer is dried and sanded down, beautiful striations of color are formed.

RUBBER COATING MAKES RUGS SLIP-PROOF

THE slipping of small rugs on polished or waxed floors is a real hazard. One or two applications of a rubber preparation sold especially for this purpose is the best remedy to prevent the rug from sliding. In an emergency, ordinary rubber cement may be used. Applied on the underside, the rubber solution can hardly be seen when dry. Small rugs are often coated only at each corner.

MINIATURE WATER-LINE MODEL OF THE

New Light Cruiser Tuscaloosa

Two views of the completed balsa wood scale model of the U.S.S. Tuscaloosa. Although it appears to be intricate, and carries abundant detail, the model is easy to build

TINY battleship models always make attractive mantel decorations, and this ship, one of the latest additions to the United States Navy, is especially graceful. The completed model has an intricate look that makes it seem like a difficult project, but actually, it is very simple to make. Constructing it is merely a matter of cutting a few pieces of balsa or other soft wood to shape, assembling them with model-airplane cement, and adding the various minor parts of wire, fiber, dowel sticks, eyelets, washers, and fine chain.

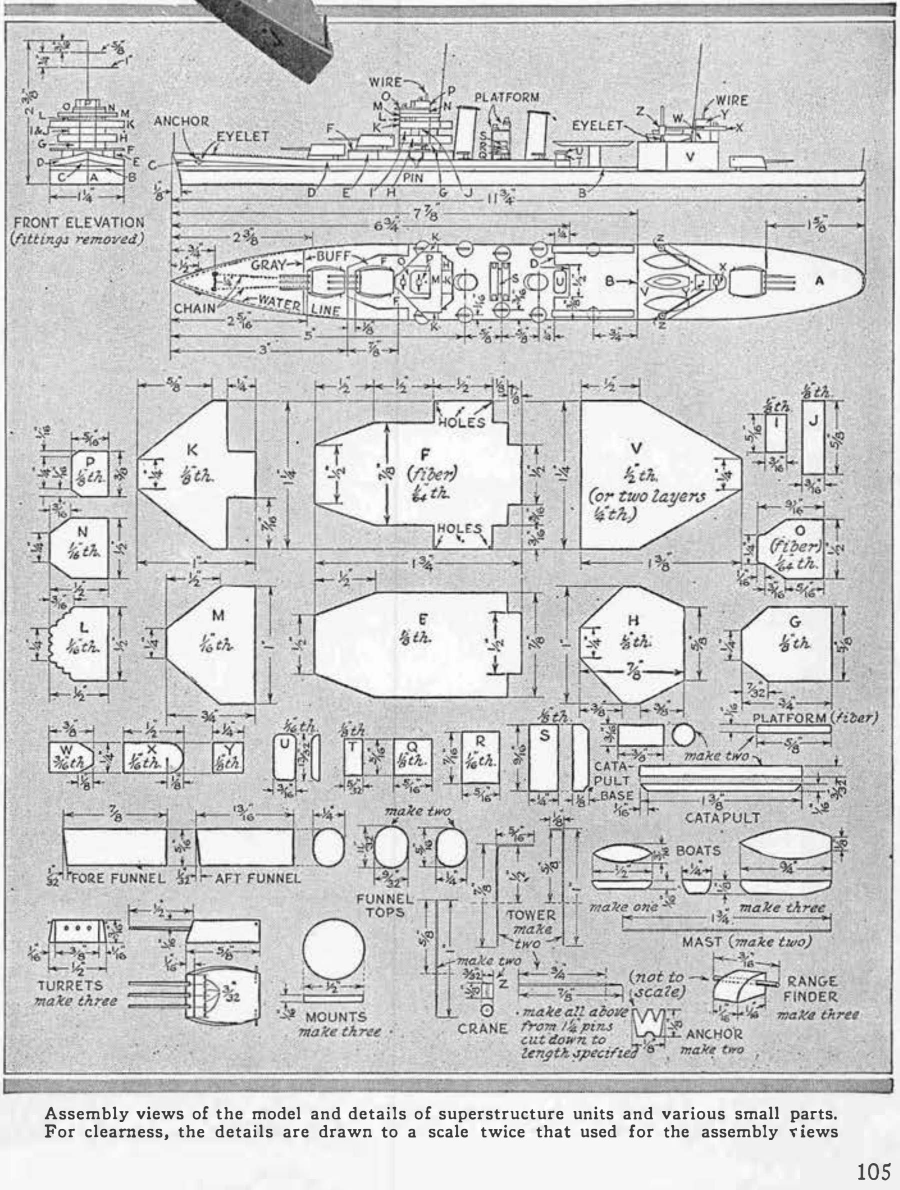
Start construction with the hull. It consists of 1 pc. balsa 1/4 by 11 3/4 by 1 1/4 in. for *A*, 1 pc. 1/16 by 1 1/4 by 7 7/8 in. for *B*, 1 pc. 1/8 by 1 1/4 by 2 3/8 in. for *C*, and 1 pc. 1/8 by 1 1/4 by 6 3/4 for *D*. These parts are cut to the shape shown in the plans, and assembled with model-airplane cement. When the cement has hardened, the sides of the hull may be brought to final shape with sandpaper.

The various parts of the superstructure are cut from 1/8-in. and 1/16-in. sheet balsa, except parts F, O, and the two platforms, which are 1/64-in. thick. The best material to use for these thin parts is hard fiber, but ordinary bristol board, or visiting cards may be used. Be sure to smooth all the wooden parts with fine sandpaper before attaching them.

The gun turrets are shaped from balsa, and the guns themselves are large pins, with the heads and points cut off. In attaching these, and similar metal parts to the balsa wood, first make a hole with a sharp pin, then dip the metal part in cement, and force it home. The small guns amidships are each made of three parts, a washer, a small eyelet, and a T-head pin with one-half of the head cut off. The catapult bases and the funnels can be reenforced by pressing small pins up through the bottom of the hull.

The masts are wire, although bamboo slivers can also be used. The anchor can best be cut from a piece of sheet brass and finished with a file, but a scrap of sheet fiber will serve as well. The anchor chains can be obtained from a piece of ten-cent-store jewelry.

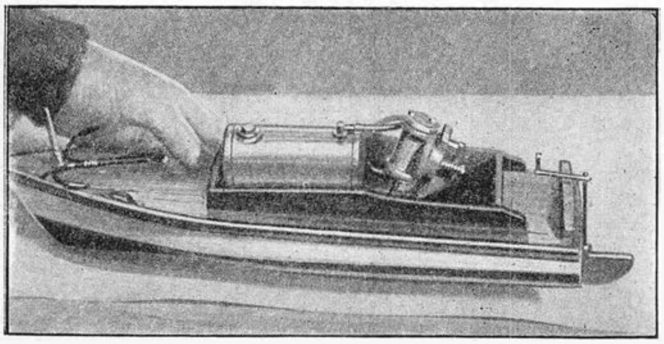
The entire model is painted gray, except the funnel tops, and the other dark parts in the photograph, which are black.



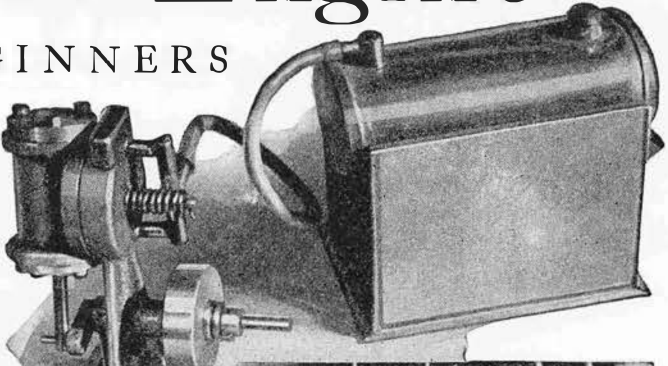
Assembly views of the model and details of superstructure units and various small parts. For clearness, the details are drawn to a scale twice that used for the assembly views

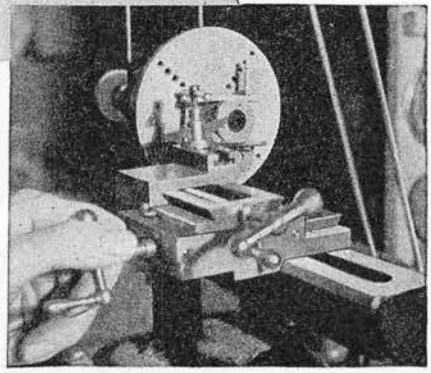
Model Steam Engine

SIMPLIFIED FOR BEGINNERS

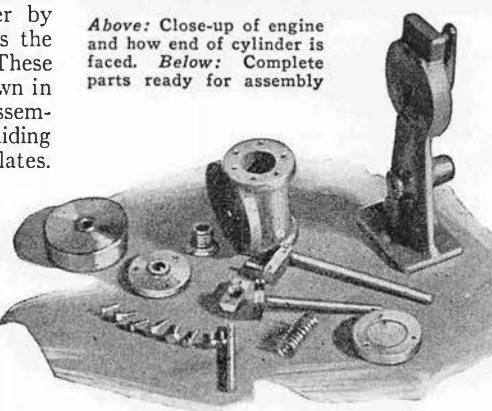


The finished engine and a small boiler installed in a model boat 18 in. long. The engine itself is only a trifle over 3 in. high





Above: Close-up of engine and how end of cylinder is faced. *Below:* Complete parts ready for assembly



Can be built without a lathe if necessary, and without castings if you have brazing equipment

THIS model steam engine has been designed as a miniature power unit that can be built with the facilities of an ordinary home workshop. As built originally, it calls for a lathe and castings, but as explained later, it can be built up from stock materials, and with nothing more elaborate than ordinary hand tools.

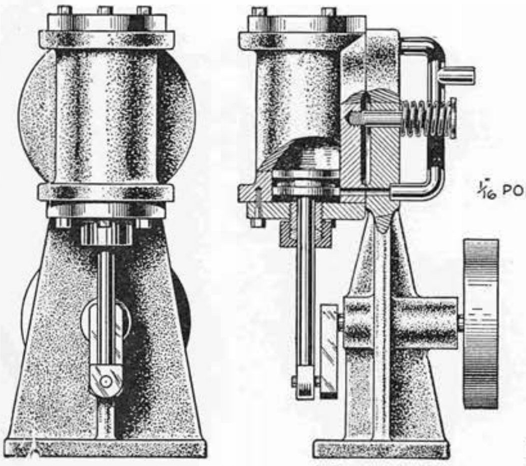
The engine stands a little over 3 in. high, has a base of 1 by 1½ in., a bore of ½ in., and a stroke of ¾ in. It will operate satisfactorily on either a pot or a flash boiler and has sufficient power to drive a fair-sized model boat.

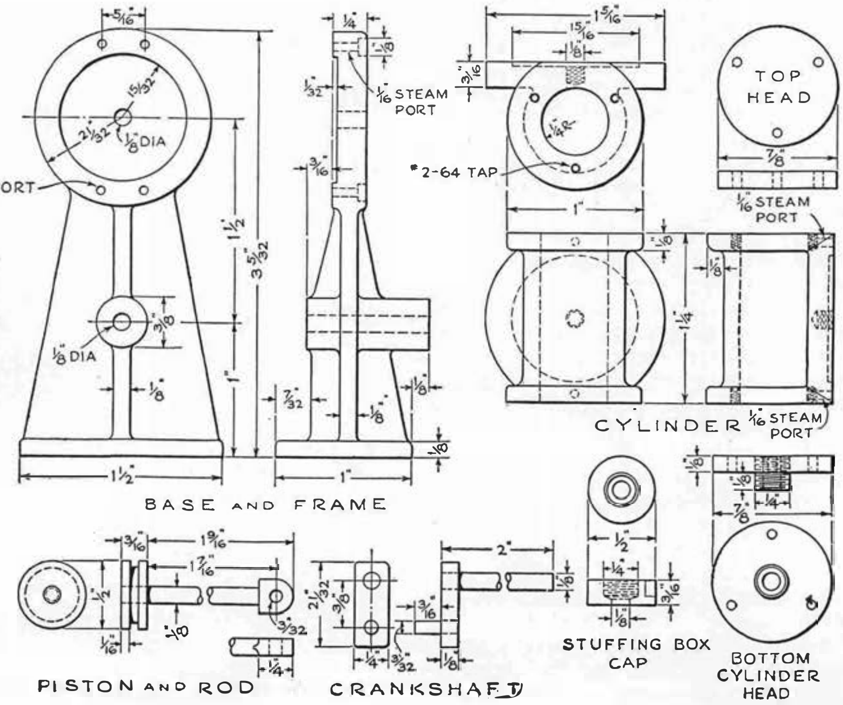
The base and cylinder are brass or bronze castings, which any brass foundry should supply from your patterns at a very moderate cost. White pine or mahogany may be used in making the patterns, with fillets of wax. Allow 1/16 in. for machining on surfaces that are to be finished.

To make the cylinder pattern, turn the cylinder from solid stock. Then turn a disk of wood 1 5/16 in. in diameter by ¼ in. thick. (This thickness includes the 1/16-in. allowance for machining.) These two pieces are fitted together as shown in the drawing of the finished cylinder assembly. The 1 5/16-in. disk forms the sliding surface on which the cylinder oscillates.

The pattern for the engine base and frame can be built up of several pieces and filleted with wax.

The cylinder may be cast solid and drilled out to ⅜ in. on a power drill press, then bored to finished size on the lathe, or core prints may be put on the pattern and the casting made with a ⅜-





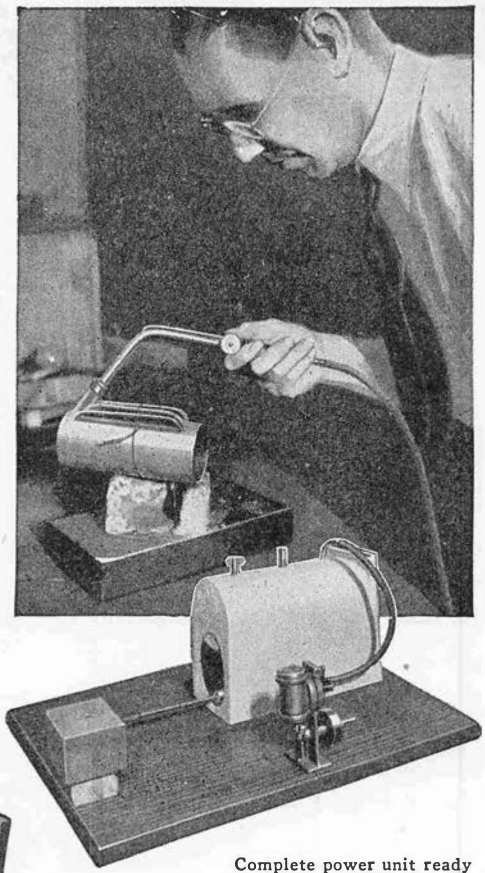
HOW ENGINE IS CONSTRUCTED

Detail drawings of all principal parts—the base and frame, cylinder, piston and rod, and crankshaft—and two assembly views, one being partly broken away to show the construction. The bore is ½ in., stroke ¾ in. While not complicated, the model will give an amateur mechanic excellent practice in pattern making and machine work in. core. Having obtained your castings, proceed as follows:

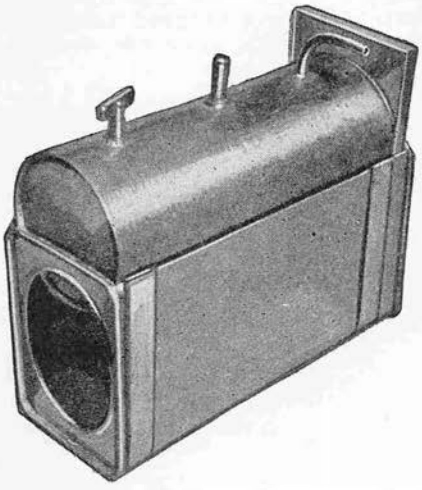
Cylinder. Mount in four-jaw chuck or on angle plate bolted to faceplate as shown so that center line of cylinder bore is in line with lathe centers. Face off one end of cylinder. The casting may then be turned end for end. If the finished end is butted against face of chuck, the opposite end will be parallel and can be faced off.

To finish surface of disk that forms back of cylinder assembly, the casting may be mounted in the four-jaw chuck or on an angle plate fastened to the faceplate. The second method is preferable. If the angle plate is used, placing one finished end of cylinder on it will insure that cylinder is at right angles to lathe bed. It is then necessary only to adjust the casting until surface of disk to be finished is at right angles to a line between lathe centers. This can be done by mounting a scriber in tool post.

After surface of disk has been finished flat, take a 1/32-in. cut across the center, leaving a 3/16-in. rim at edge to reduce bearing.



Complete power unit ready for use and, above, brazing the tubes with silver solder



The boiler and cocoa-can housing assembled preparatory to covering them with asbestos

To bore cylinder, mount it on an angle plate with one finished end flat against the surface of faceplate. Adjust until a line between lathe centers coincides with center line of cylinder bore. With boring tool, bore cylinder to finished size. The last cut should be fine, with a slow feed. The cylinder will be lapped in after piston has been made.

Drill steam ports as shown. Holes for cylinder-head bolts may be drilled and tapped to suit your convenience. Use 0-80 hexagon-head machine screws if you can get them. Cylinder heads may be of ⅛-in. sheet brass.

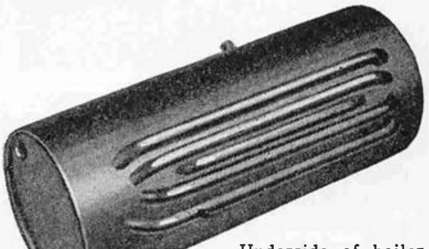
For the stuffing box, thread a piece of brass rod ¼ in. in diameter. Turn it into a threaded hole in center of lower cylinder head and cut off to required length. Then drill a ⅛-in. hole through center for piston rod. This hole should be drilled a trifle undersize and finished with a ⅛-in. straight reamer. The stuffing-box cap can be made from a piece of ½-in. round brass stock.

Base and Frame. File bottom of base flat. Mount on faceplate. Block up until circular portion at top, against which cylinder oscillates, is at right angles to lathe bed with its center coinciding with a line between lathe centers. Turn this face flat, then recess the center portion like disk at back of cylinder. While casting is still in position, drill a ⅛-in. hole through center of this circular portion for bearing bolt that supports cylinder.

By turning lathe at slow speed and taking light cuts, the front end of shaft bearing can be faced off at this time. Change position of casting so that shaft bearing is in line with the lathe centers. Using a surface gage resting on lathe bed, adjust so that the disk surface just finished is at right angles to line between lathe centers. Using chuck in tailstock, drill and ream shaft bearing with a ⅛-in. hole. Reverse casting and square off other end of shaft bearing. Drill steam ports with hand drill or drill press. (The photos show a rectangular piece at top originally intended for attaching an exhaust stack, but found unnecessary and therefore omitted from the drawings.)

Piston. Turn from steel rod. The shaft is ⅛-in. drill rod or cold-rolled steel, threaded at one end and screwed into a hole tapped in center of piston. If cylinder is carefully bored and piston is lapped in, no piston ring is necessary. The groove in piston will hold oil and prevent undue leakage. If desired, however, a split ring can be made.

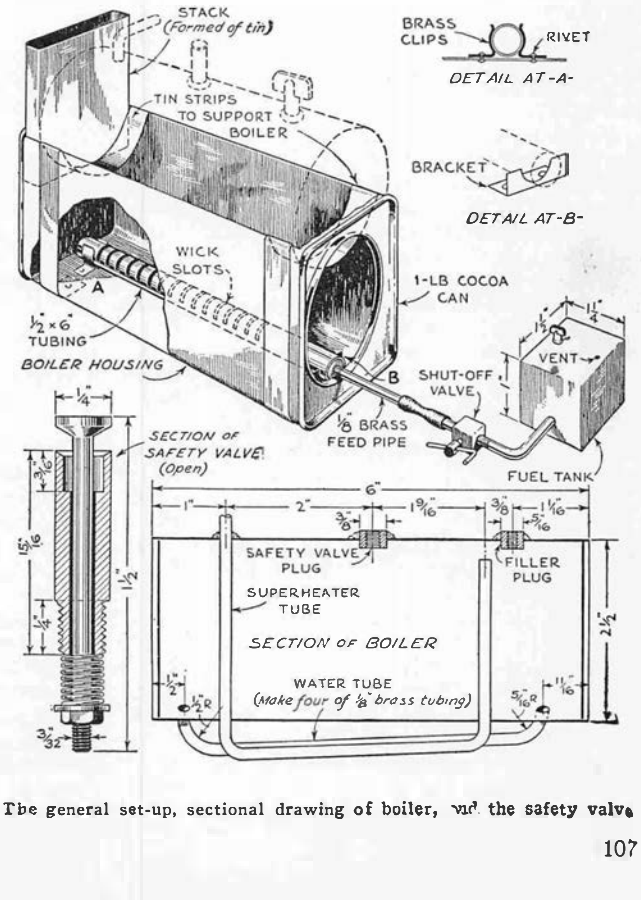
Crankshaft. Build up from ⅛-in. cold-rolled steel.



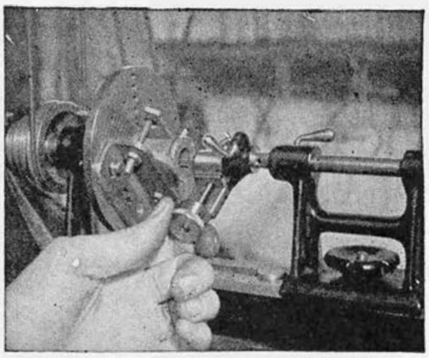
Underside of boiler. The tube in center is the superheater tube

Assembly. The cylinder is held against engine frame by a ⅛-in. bearing stud, screwed into a hole tapped in rear of cylinder. A coil spring holds cylinder against frame. The tension should insure a close fit, but should not interfere with free oscillation of the cylinder. Cylinder and engine-frame surfaces should be lapped together with fine valve-grinding compound. The piston should also be carefully lapped into the cylinder. The flywheel is turned from brass and keyed to shaft, or may be a driving fit.

Alternative Construction. By making a few changes in design, it is possible to construct an engine of this type without a lathe. The cylinder may be made from a piece of heavy brass tubing or from a brass bushing of suitable size and bore. A disk of heavy brass can be sweated to one side and filed flat. Then the surface should be



The general set-up, sectional drawing of boiler, and the safety valve



Boring cylinder with small boring attachment

scraped down so that only a small area around the steam ports is in contact with the bearing surface of the engine frame. Other surfaces can be filed smooth. In finishing the engine frame, file the surface against which the cylinder oscillates as flat as possible; then scrape down all but a small area around the steam ports.

IF brazing equipment is available, no castings need be made. The engine frame can be of heavy sheet brass sweated together.

Action. Steam is led to engine through brass tubing which enters both inlet ports, one at top, the other at bottom. Check ports so that connection is made with proper holes. When piston is at top, the port in cylinder should be in line with inlet port in engine frame. The lower inlet port in frame will then be covered by the cylinder, while the hole in lower end of cylinder will be in line with lower exhaust port in frame. When piston is driven downward, steam is driven out of lower exhaust port.

The boiler, although designed especially for this engine, is suitable for use with any small steam power plant. It is particularly suitable for installation in model steamboats of the slower type where a high-pressure flash steam system is not required. Among its advantages are simplicity of construction, low cost of materials, a unique and efficient heating unit, and safety.

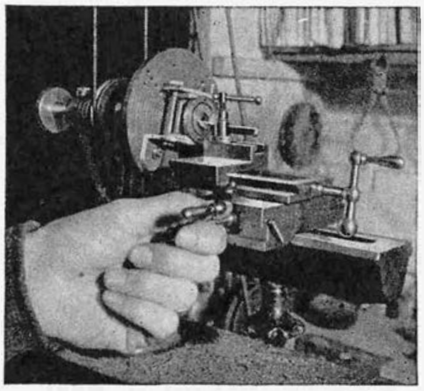
Materials. One piece seamless brass tubing 2½ in. in diameter by 6 in. long. Six feet seamless brass tubing of ⅛-in. inside diameter. One piece copper or brass tubing ½ in. in diameter by 6 in. long. One piece 1/32 in. thick sheet brass, 6 by 8 in. for boiler ends and fuel tank. One 1-lb. cocoa tin of the type shown for boiler housing, ¼ lb. plastic asbestos, and a little asbestos wool. The safety valve, filler plug, and other small parts can be made from scrap material.

Making Boiler. Square and smooth ends of 6-in. length of 2½-in. brass tubing. Cut two disks of heavy sheet brass to fit snugly in ends.

ANNEAL ⅛-in. tubing by heating to a dull red and quenching in water. Take the entire length of tubing and, leaving enough stock to hold onto with a pair of pliers, make the first bend. Then, using the hands only to hold the tubing, make the second bend the proper distance from the first to form one of the water tubes. Saw off and trim to exact length.

As shown in cross secion of boiler, the super-heater tube has its open end inside boiler about ¼ in. from the top. The tube then passes down through bottom of boiler and along underside between the water tubes, enters boiler again at opposite end, and passes up through top.

After all tubes have been formed and ends filed square and smooth, spot the ten holes on bottom of boiler into which the tubes are to be soldered. Drill holes a trifle undersize and file ends of tubes to a snug fit. Ends of water tubes should project into boiler about 1/32 in. Put tubes in place and bind securely with iron wire. If you have access to a brazing torch, the soldering should be done with silver solder. However, since the boiler operates at low pressure, a careful job of soft soldering will serve.



Turning recess in disk at rear of cylinder

NEXT solder in the end plates, which should fit closely. First spot-solder them at three or four points around the edge, placing them about ⅛ in. in from ends of boiler. Using light hammer blows while rotating the boiler on an anvil or iron block, carefully turn ends of boiler in over end plates.

Filler Plug and Safety Valve. The filler plug is simply a screw plug, seated in a short length of drilled and tapped brass rod soldered in top of boiler. If you do not care to buy a safety valve, a simple one can be made of scrap brass as shown. By varying tension of spring, the valve can be adjusted to pop at the desired pressure. The adjustment can be made at any filling station having an air pump that can be set to deliver air at different pressures.

Housing. The 1-lb. cocoa can is exactly the right size, but light gauge sheet iron can be used if desired. Carefully cut out one entire side of the cocoa tin. Then, with ¾-in. strips of tin or light brass, form straps to support boiler so that it drops half way into can. It will be found that the can is ½ in. longer than the boiler. This space is left at the rear and serves as an opening for the stack, which is formed of tin. The stack should run from bottom of boiler to any desired height.

Strips of brass or tin may then be fastened to bottom of boiler housing for mounting purposes. Next rivet in place the clips or supports for burner as shown.

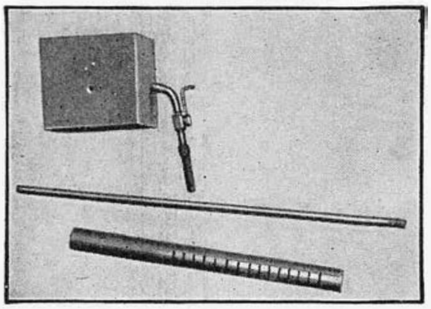
After assembling boiler, stack, and housing, bind boiler firmly in place with copper wire. Then cover entire assembly with a ¼-in. layer of plastic asbestos.

Burner. Take a piece of ½-in. brass or copper tubing and with a hack saw make eighteen cuts ¼ in. apart, each halfway through the tube. Close one end of tube with a plug. Cut a plug to fit other end and drill a hole through plug to receive a piece of ⅛-in. brass tubing. Take a piece of ⅛-in. tubing about 10 in. long and, starting at one end, drill sixteen or eighteen holes ¼ in. apart with a No. 60 drill. Insert this fuel supply tube in burner tube as far as it will go; then pack unit with asbestos wool. Slip plug over protruding end of fuel supply tube, slide it into place, and crimp burner tube over plug. With a pin, pull a portion of the asbestos wool out through each of the slits in burner tube to form wicks. These wicks should be about ⅛ in. long. The burner tube is held in position by the bracket and clip shown.

The fuel tank is simply a small sheet brass tank or a can of suitable size. Insert a small shut-off cock between fuel tank and burner.

Operation. Open shut-off valve, allowing the fuel, which is alcohol, to run down into the burner. The size of the flame may be regulated by the valve.

If used in a boat, the fuel tank may be located in any convenient place so long as it is higher than the burner. Boiler and engine should be so placed as to make the distance from the boiler steam outlet to the engine as short as possible. A small globe steam valve should be inserted in steam line between boiler and engine. The photo of the entire power unit shows the engine connected to the boiler by a length of rubber tubing. At 25-lb. pressure this is entirely satisfactory where flexibility is desired in making tests and adjustments and in experimenting with the unit. Thick-walled rubber tubing of the type used on auto windshield cleaners is satisfactory.



The ½-in. burner tube with wick slots, the ⅛-in. feed tube, and tank for holding fuel

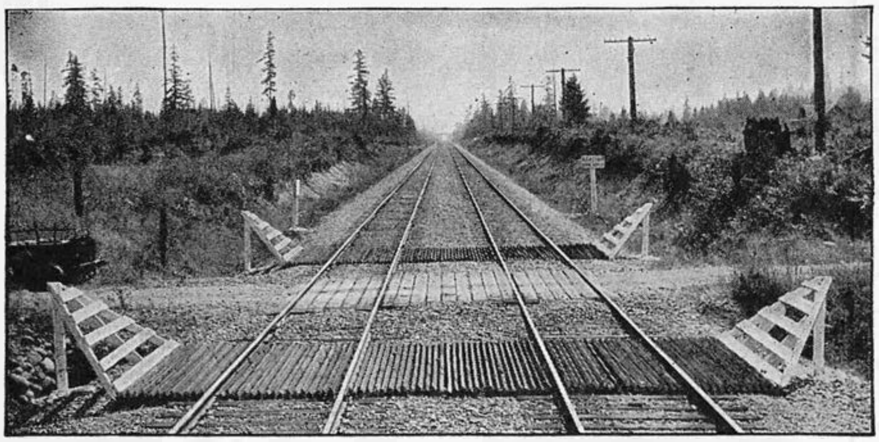
This type of boiler can be altered slightly for high-pressure use in a speed boat on short runs by adding a water gauge and substituting a gasoline burner of the blow-torch type. By a few experiments with the throttle wide open, it can be determined just how much fuel can be used at one filling without exhausting the water supply.

THREAD GLUED ON MODEL HULL FOR PAINTING WATER LINE

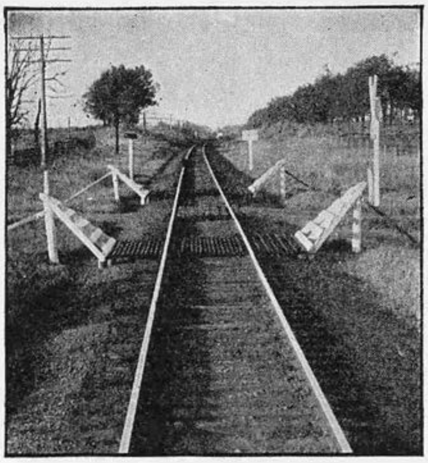
When it is difficult or inconvenient to use masking tape in painting a clean-cut water line on a ship-model hull, the same result may be obtained by fastening a very thin cotton thread to the dividing line by means of a light adhesive. The thread serves as a guide to keep the paintbrush from crossing to the wrong side and insures a much neater job than if the line is painted free-hand. This idea can be utilized for almost any kind of painted division lines on models or similar small work.

MINIATURE Crossings *and* Signs

IMPROVE A MODEL RAILWAY



A fully planked grade crossing over a double main track with cattle guards (see drawings below)



A planked grade crossing over a branch line with one crossing sign and a "Station One Mile—Water" sign at the right of the track

ANY long stretch of model railway track that seems bare or uninteresting can be improved by adding a highway grade crossing with its various signs.

Figure 1 shows some of the most common signs. The drawing is almost self-explanatory, but the following specifications, copied from the original plans, may be helpful: "Posts to be of round cedar, stripped of bark, not less than 6 in. in diameter at the top. Posts and boards to be painted white with black lettering. Crossing signs to be lettered on both sides and posts to be striped black and white." These specifications apply to all of the signs except the whistle post and mile post shown at *F* and *G*, Fig. 1. These two signs are of metal, the posts usually being made of old boiler flues, and the boards of boiler plate. Both signs are painted white with black letters. The whistle post should be lettered with a large W on one side only.

In making the wooden signs, use dowel sticks for the posts, and for the signboards either white cardboard or the thin wood found in berry boxes or safety-match boxes. White cardboard such as is used for business cards has its advantages: it doesn't have to be painted, will not split, and takes drawing ink nicely.

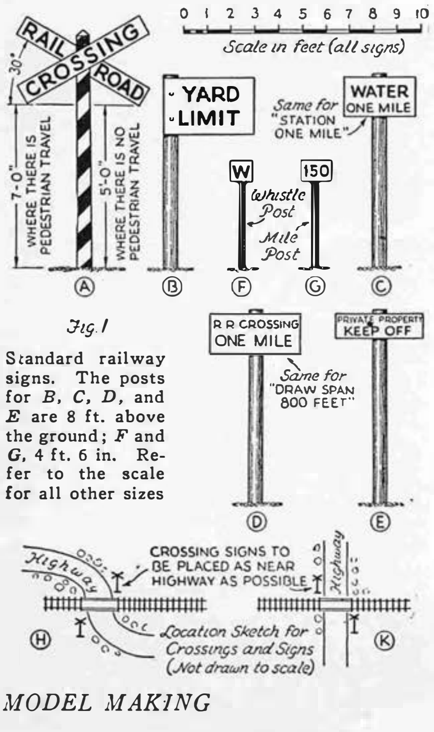
As to location, signs *B, C, D, F,* and *G* should be placed 10 ft. to scale from the near rail and at right of the track. For the crossing signs the specifications read as follows: "One sign only shall be placed at the grade crossings of unimportant highways over one track. Where two signs are required, place one on each side of the track on the right-hand side of the highway unless local conditions require left-hand location. [See sketch *H* and *K,* Fig. 1.] Signs to be placed as near highway as possible and not more than 75 ft. from nearest rail."

Figure 2 shows the details of a plank grade crossing, usually 16 ft. wide. At unimportant crossings where there is little travel, such as farm crossings, only four planks are used. These are placed one at each side of each rail, and the center between the planks is merely filled with gravel.

If your right of way is fenced, it will be necessary to add cattle guards as shown in Figs. 3 and 4. The drawing is made in detail, and it will probably be necessary to simplify the actual construction to some extent. For instance, if your road is built to a scale of ¼ in. to the foot, the slats would be only 3/32 in. in height. This is entirely possible, of course, but your passenger trains will run just as fast and the freight trains haul just as much freight if these finer details are omitted.

HAND DRILL SERVES AS SMALL LATHE FOR MAKING MODELS

THE model maker in a city apartment usually finds it impractical, if not impossible, to use machines. A small electric hand drill set in a small vise clamped to a table edge can, however, do duty as a lathe for small projects. Satisfactory work can be done in tapering spars, turning guns, stanchions, and the like, by setting the piece horizontally in the chuck and using a narrow chisel, files, and sandpaper.



0 1 2 3 4 5 6 7 8 9 10
Scale in feet (all signs)
RAIL ROAD
CROSSING
30°
7'-0" WHERE THERE IS PEDESTRIAN TRAVEL
5'-0" WHERE THERE IS NO PEDESTRIAN TRAVEL
YARD LIMIT
Same for "STATION ONE MILE"
WATER ONE MILE
W
150
Whistle Post
Mile Post
A
B
F
G
C
R R CROSSING ONE MILE
Same for "DRAW SPAN 800 FEET"
PRIVATE PROPERTY KEEP OFF
D
E
Highway
CROSSING SIGNS TO BE PLACED AS NEAR HIGHWAY AS POSSIBLE
Highway
H
K
Location Sketch for Crossings and Signs (Not drawn to scale)

Fig. 1

Standard railway signs. The posts for *B, C, D,* and *E* are 8 ft. above the ground; *F* and *G,* 4 ft. 6 in. Refer to the scale for all other sizes

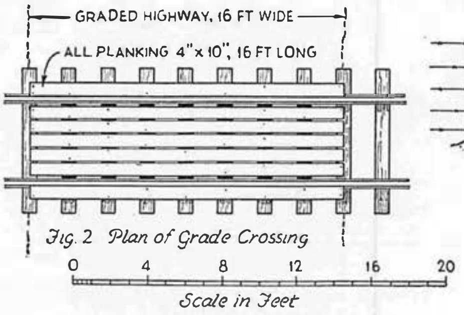
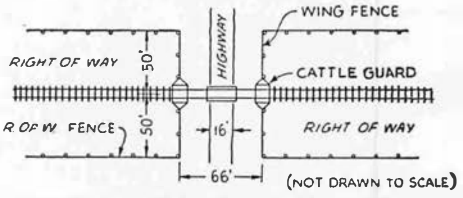
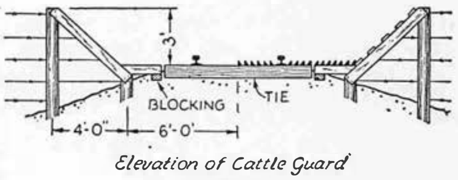


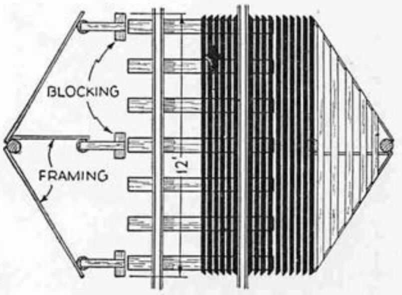
Fig. 2 Plan of Grade Crossing



Location Sketch Showing Right of Way, Fencing, Highway Crossing and Cattle Guards)
Fig. 5

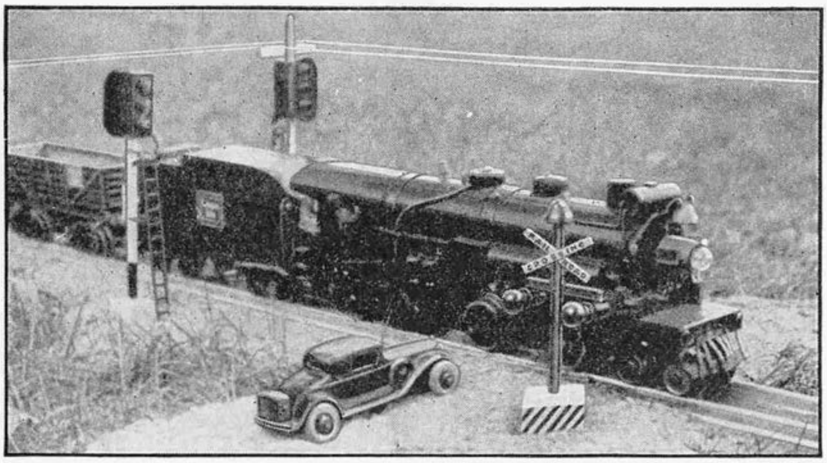


Elevation of Cattle Guard
Fig. 3



Plan of Cattle Guard
Fig. 4

Planked crossing and cattle guard, and a diagram showing the arrangement at a typical crossing



Highway Flasher Signal

ADDS REALISM TO MODEL RAILWAY

A WELL-DESIGNED model railroad usually includes at least one highway crossing at grade, which, in line with modern railroad practice, should be automatically protected. The accompanying drawings show a flasher signal for an "O" gage railroad. The pole consists of a piece of ¼-in. outside diameter brass tubing cut to a length of 3¾ in. The cross arm is a piece of 3/16-in. square brass rod 1⅝ in. long. This is bolted to the pole at a height of 2⅝ in. from the bottom. Two socket shells are soldered on the underside of the cross arm, pointing at right angles from the arm. These shells may be obtained by taking apart miniature porcelain-base sockets, or may be purchased at some electrical supply dealers. The lamps are miniature flash-light bulbs painted with two coats of vermilion lacquer or enamel. A smooth, even coat may be put on if the bulbs are kept alight while being painted. When the lamps are lit, it is easy to detect streaks and thin spots that would otherwise go unnoticed.

The foundation of the signal is diamond shaped. A notch is cut in the pole ⅜ in. from the bottom, and a 3/16-in. hole is drilled through one side of the foundation to correspond in position with this notch. The wiring from the lamps then may be run inside the pole and out through the side of the foundation. If the builder prefers, the wiring may be run directly out through the bottom of the pole provided connections can be made under the baseboard of the track. The foundation is fastened beside the track with wood screws.

A 3/16-in. hole should be drilled in the back of the pole ½ in. below the cross arm. This is for the wires to enter the pole from the lamps. Radio "spaghetti" tubing should be used to inclose the wires where they enter and leave the pole. This gives the effect of "flexiduct" tubing used by railroads under similar conditions.

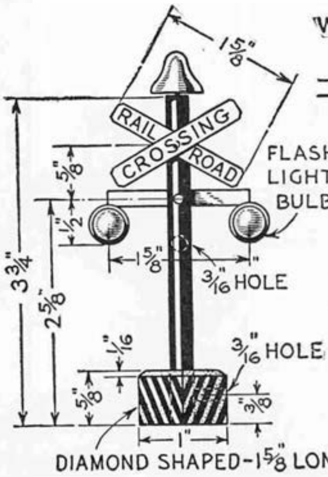
A crossing sign may be included on the pole. It should be fastened ⅝ in. above the cross arm. The sign should be made of 20-gage brass cut ¼ in. wide and 1⅝ in. long. The two pieces are drilled in the center and bolted to the pole with a 2-56 machine screw. Either a pinnacle or a dummy bell may be added as a finishing touch at the top of the pole.

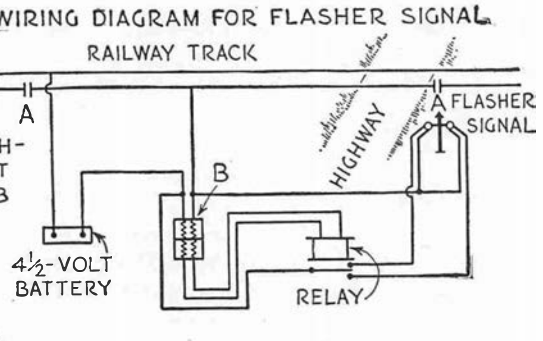
The base is painted white to imitate concrete and has diagonal black stripes on all sides. The pole, cross arm, sockets, and pinnacle are painted black, while the sign is painted white with the words "RAILROAD CROSSING" printed in black.

Three wires are necessary, one to each lamp and a common wire fastened to the pole, preferably under the bolt holding the cross arm in place.

As shown in the wiring diagram, one running rail of the track is insulated at points *A*. One of these points should be right at the highway crossing, while the other is at a sufficient distance so that the flasher will give a realistic warning of a train's approach. *B* is a thermal flasher device used for making Christmas-tree lights blink. It is of the type that screws into a miniature socket, and itself includes another socket of the same type. It should be mounted by screwing it into a porcelain-base socket connected as shown. Two wires are fastened to the outlet or socket end of the blinker, preferably by soldering. If difficulty is experienced in reaching the center contact to solder the connection, the same results may be obtained by carefully breaking the glass of an old flashlight bulb and soldering the two wires directly to the filament leads therein. This may then be screwed into the blinker socket and used like a regular electric-light plug. This done, it is necessary only to run the wires to the relay and flasher signal.

A train passing the insulated joint makes a connection between the two running rails. This completes the circuit and allows the battery current to flow into the blinker, which causes the relay to open and close at regular intervals. The light circuit is wired through the relay and track so that when no train is on the section, neither lamp is lit. However, with a train approaching, the lights will alternate as the relay opens and closes, giving the same blinking effect as a standard crossing signal.

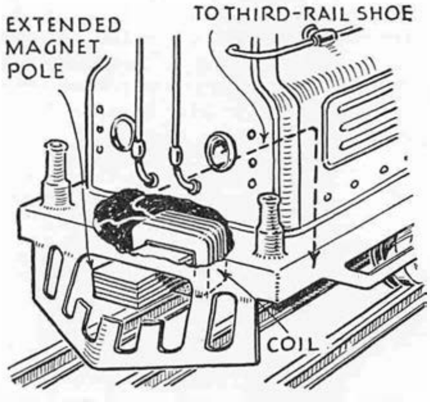




Highway crossing signal with dimensions suitable for an "O" gage model railway. The proportions can easily be changed for other gages. Points marked *A* in the wiring diagram are where one rail is insulated; *B* is a Christmas-tree lamp flasher

MAGNETIC COUPLER FOR MODEL SWITCH ENGINE

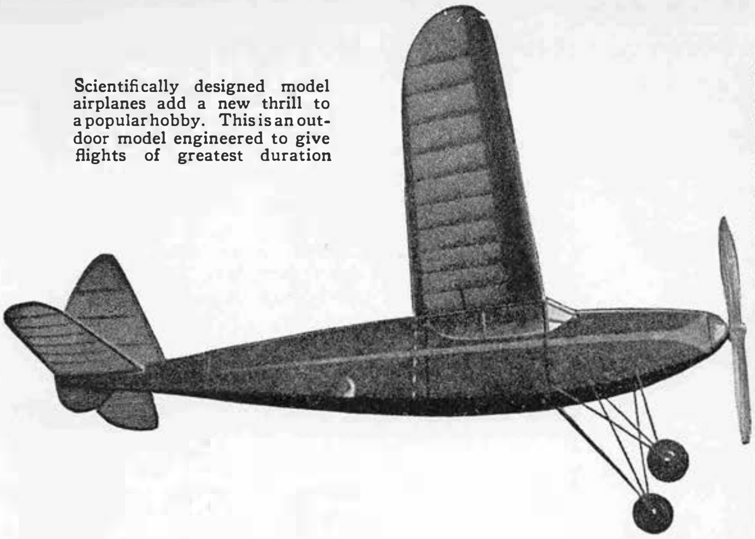
A NOVEL feature for model switching locomotives is an automatic magnetic coupler. It will not handle long trains, but realistic switching operations can be carried on with one or two cars at a time.



Model locomotive with a magnetic coupler that works automatically for switching cars

The coupler consists merely of a small electromagnet at one (or both) ends of the locomotive, projecting through an opening cut in the pilot. The magnet core is made of layers of transformer iron, or even tin-can stock. For an 0-gauge locomotive, its cross section should be about ⅜ by ⅜ in. This is wound with about 300 turns of No. 28 enameled wire. One end is connected to the frame, and the other to the third rail shoe.

Coupling is accomplishd when the magnet makes contact with a car coupler. Uncoupling occurs when the current is cut off while the locomotive is pushing, so the car coasts out of range.



Scientifically designed model airplanes add a new thrill to a popular hobby. This is an outdoor model engineered to give flights of greatest duration

NEW Thermal Hunter PLANE MODEL

Built to Break Records

HERE is a model airplane that may break the existing world records for flight this summer. By utilizing the rising air currents, this so-called "thermal hunter" quickly attains considerable height, and its gliding range is much longer than the average miniature craft.

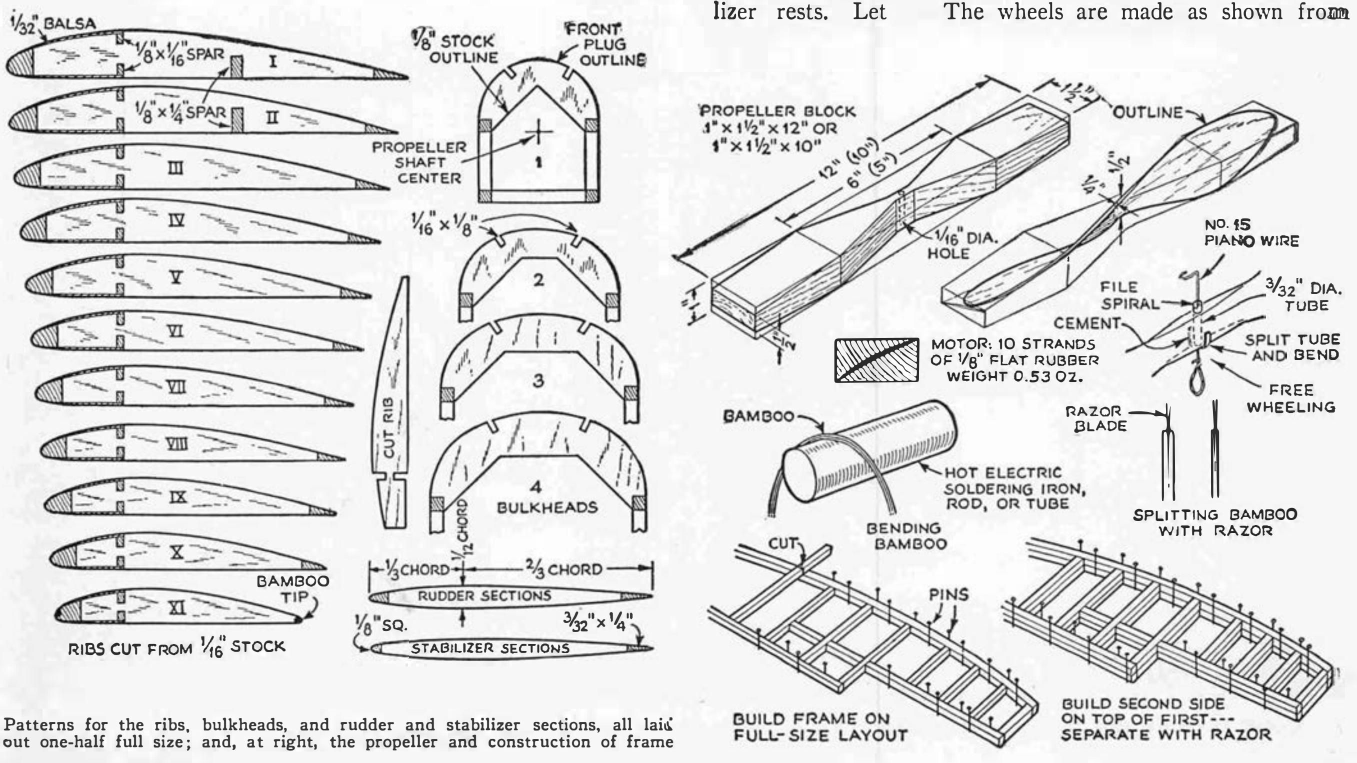
With most of the present outdoor records well over the half-hour mark, model airplane builders are faced with the problem of how to establish new records. The propeller run of an average model is between one and two minutes, and the problem is how to get the needed extra thirty to forty minutes. The qualities needed are lightness, streamlining, a high climb, and a good glide. Lightness and strength is had by using sheet-balsa in the form of box construction. Streamlining is just a matter of having a good shape with round corners, sanding and polishing all moving elements, and lining up the thrust line with the wing and tail incidences. High climb depends on the amount of rubber used. The glide depends on the adjustments made on the model while testing.

Draw the fuselage outline and uprights on white paper, tacked to a soft board, and wax all points at which the cement is likely to touch it. Stick pins on this outline wherever the uprights meet the longerons, and where the curves are severe. Hold the longerons in place against the pins with other pins. Fit the uprights with emphasis on the proper angle. Make two uprights at a time and set one aside for use on the opposite side. After one side is finished and recemented, the other side can be built right on top of it.

The two sides are assembled by cementing the center cross braces first. Line up the sides and hold them in position with square blocks. The remaining braces are cemented from the center out. The braces should be cut to size before assembling. Note the extra large braces at the front and at the rear-plug point. Also note the curve as well as the incidence of the stringers on which the stabilizer rests. Let the fuselage stay in the jig until the cement is dry.

The landing gear is made of wire because it cannot be broken. The tripod system is used so that no soldering is required. Bend the wire to the shapes indicated. The axle portion is of X-form with the upper portion closed. The four struts are made from one piece of wire so shaped as to form two V's connected by a flat upper portion, which is fixed to the fuselage. Note how the connecting loops are made. Place the shaped wire in the fuselage without fixing it until the loops are connected. After the loops are intertwined, the wire is bound and cemented to the cross braces and longerons.

The wheels are made as shown from



Patterns for the ribs, bulkheads, and rudder and stabilizer sections, all laid out one-half full size; and, at right, the propeller and construction of frame

STREAMLINED OUTDOOR DURATION FLYER CLIMBS ON ITS OWN POWER AND GLIDES A LONG WAY ON RISING AIR CURRENTS

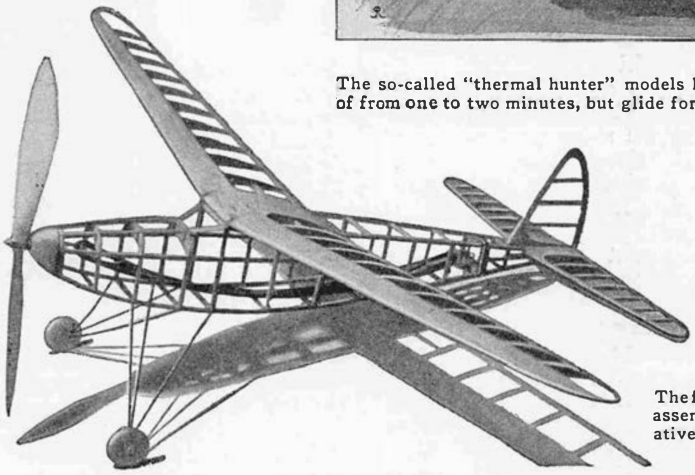
hard balsa. The axle bushing is a piece of tubing with an end split to allow for curving the two sections into the wood. The tube should extend beyond the wheel to coöperate with the axle back hook.

The bulkheads are cut to sizes from ⅛-in. hard balsa. Cement them in place and fix the stringers into the slots. The front portion of the fuselage is covered with 1/32-in. sheet balsa to provide the needed handling strength. Start the covering on the upper curve first and trim the sheet to the halfway thickness of the stringers. The subsequent sheets must be fitted to this cut. If the balsa cannot be bent to shape for full length, the stations difficult to handle may be covered individually.

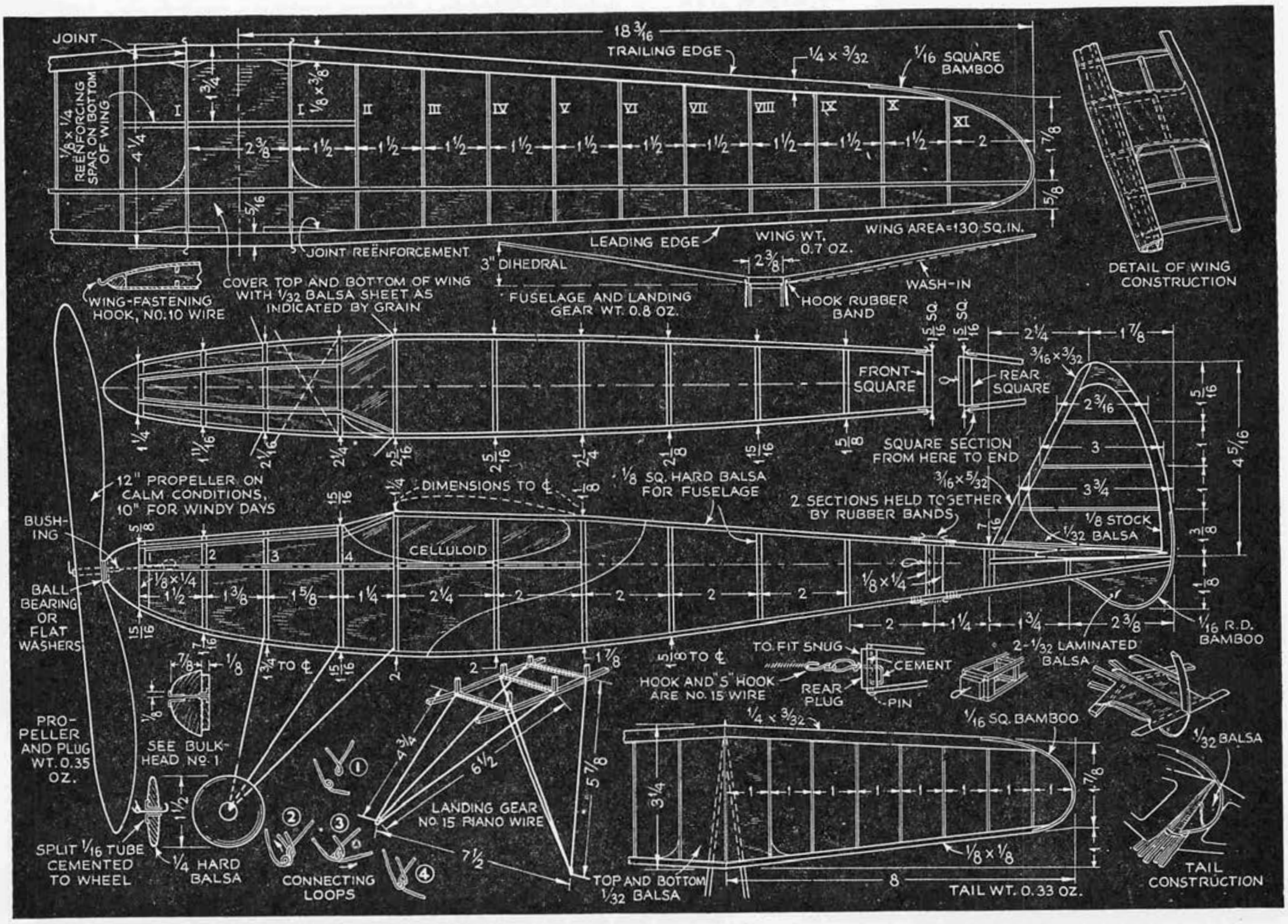
The front plug is carved to shape from hard balsa. The sizes are determined by the opening of the first bulkhead for the ⅛-in. stock, and the outline by the balsa covering. The plug should fit snugly to provide frictional contact for holding it in while the model is gliding. Be sure to have the required down thrust by holding the plug at an angle while drilling the shaft hole.

Carve two propellers, one 10 and the other 12 in. The smaller size is used for testing and gusty weather, while the larger size is for calm days. Sand to shape with rough sandpaper and finish with No. 10/0. The blades should be doped with two coats of cement, sanded, and polished. They may also be covered with silk for strengthening. The "free wheeling" is made from a metal tube by cutting a spiral on one end and splitting the other end

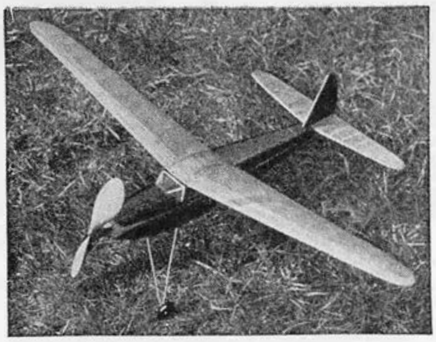
The so-called "thermal hunter" models have a propeller run of from one to two minutes, but glide for many minutes more



The framework of the model assembled to show the relative position of the parts



Working drawings of the wing, fuselage, tail, landing gear; diagram showing the dihedral and "wash-in"; and a variety of construction sketches



The model lands safely from a test flight

for fastening to the propeller as shown.

The front plug and the propeller can be assembled by making the rubber end of the propeller shaft first. Slip on the plug, ballbearing washer, and then the prop. Hold the propeller in place by bending the spiral engaging hook as shown. If your local supply shop does not have the ball-bearing washer, three well-oiled flat washers will do.

THE stabilizer is made over a full-size outline and rib plan. The bamboo tips are bent in one piece held over a gas flame or heated metal until the bamboo is pliable for shaping to the outline by hand. The curve, when cold, is cut in two halves, which are trimmed to size and cemented to the spars. Remove the stabilizer and check for perfect taper by sighting along the curved rib edges, and sanding down the high points. Cover the center section with 1/32-in. balsa, top and bottom. Sand and smooth all rough spots. Cement the finished stabilizer on the stringers as shown, and be sure that it is horizontal.

The rudder, minus the lower rib, is assembled on the full-size plans. Cement the front spar to the cross brace, and rear spar to the stabilizer. Fit in the bottom rib and cement it to the rudder and stabilizer. The skid portion is made by bending the bamboo to shape and fixing it to the lower cross brace, to the end of the longerons, and to the rudder's trailing edge. The bamboo outline is stiffened by a laminated balsa assembly, which is cemented to the outline and the lower portion of the stabilizer. The skid is held centrally by balsa sheets cemented to the longerons and skid sides. Finish the tail by covering the front portion of the rudder with balsa sheet.

Before cutting the longerons at the plug end, make eight small hooks, which are bound and cemented to the longerons as shown. After the two sections are separated reenforce the front square with cement fillets. Into the rear part fit two balsa laminated squares with the end hook attached as shown. Be sure that they are strongly made since they have to take care of the rubber torque.

THE wing is made over a full-size outline. Make full-size drawings of the ribs, transfer the outlines to the balsa, and cut the ribs with a razor blade exactly on the line. Note the two small cutouts for center spars. Rib No. 1 and No. 2 have an extra cutout near the trailing edge for the reenforcing spar. Taper the spars to the sizes shown.

Make the wing in two halves. Set the finished halves over the plan, hold the center ribs in place with pins, and raise and block the tips 3 in. for the dihedral. Cement in place the center section spars, fillets, and other reenforcing members. Let set for a quarter of an hour; remove, and fix in the lower center spar and the short rear spar.

The strength of the wing is almost doubled by covering the leading and center portion with a balsa sheet, as shown by the grain lines. Work from the center spar out, and let the sheet overlap the leading edge. This portion can be sanded later to the rib outline. Sand and finish with No. 10/0 sandpaper.

Colored tissue is used for covering, yellow for the wing and stabilizer, and red for the fuselage and rudder. On this kind of paper the grain must be lengthwise on fuselage and spanwise on wing and tail. Use dope for cement. Cut the paper to an approximate size and tack it at only one point on the middle of the center rib. Now coat the entire tip rib and cement the paper to it so that it will form a smooth triangle with the apex at the center. Keep the tension while the dope is setting. Finish the covering by coating spars and fixing paper from tip toward center. The next operation is to break the center tack and cement the paper on the center portion of the wing or tail surface. The paper will be fastened to the uncemented ribs when the surfaces are doped. On the fuselage the paper must be cemented to all the uprights and cross braces.

The wrinkles are removed by wetting the paper with water. While the paper is drying, the wing or tail can be straightened.

The model is coated with one or two applications of regular model dope. The celluloid windows are then cut and cemented.

ASSEMBLE the model with rubber bands. Make up a 10-strand motor of ⅛-in. flat rubber, brown preferred, and place it inside the fuselage. Be sure to use safety hooks throughout. Check the line-up. Everything should be straight except the right wing, facing the model, which should have a slight "wash-in" to counteract the torque. It is very important that the model is balanced exactly 1½ in. behind the leading edge on the center portion. If the balance is off, correct it by adding the required weight.

Test flights should be made on calm days or during the twilight, when the wind dies down. For the first glide, the motor is wound 50 to 70 turns. If it flies well on this power, try more turns. If the model stalls on this low wind-up, check the C.G. If the C.G. is all right, note if the incidence of the stabilizer is too negative. A dive calls for the same check up except that the stabilizer might be positive. Correct any misalignments found, and make another test. If it still misbehaves, keep on checking the wing, the C.G., and the tail settings.

IF THE model tends to bank sharply, check the incidence of the wing which is on the outside of the circle and also the rudder setting. Decrease the incidence or neutralize the rudder. By now the model should behave fairly well, and it can be wound up from 250 to 300 turns for checking the glide.

After the model is fairly stable, it is wound about 400 turns, and then hand launched into the breeze. The glide should be flat without stalling and should circle to the right.

The climb adjustments are made by offsetting the thrust line. If the model has a tendency to stall, the propeller is pointed down by placing a balsa strip between the plug and the fuselage. Keep on adding down thrust until a smooth climb is obtained. If the model has a tendency to spiral with the torque, have the prop. pull to the right side until the ship climbs straight up or with a slight left turn. After the correct offsetting is found, the plug can be cut to suit.

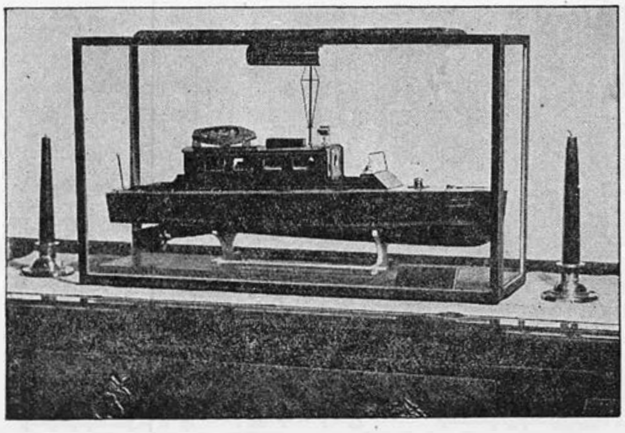
The model conforms to the National Aeronautic Association model competition rules, both in fuselage cross section and wing loading of 1 oz. per 50 sq. in. of wing area.

AQUARIUM FORMS MODEL DISPLAY CASE

IT COSTS considerably more to buy parts and fabricate model display cases than it does to purchase production-made aquariums, which may then be converted into display cases quickly and easily. Still more important is the fact that much labor will be saved.

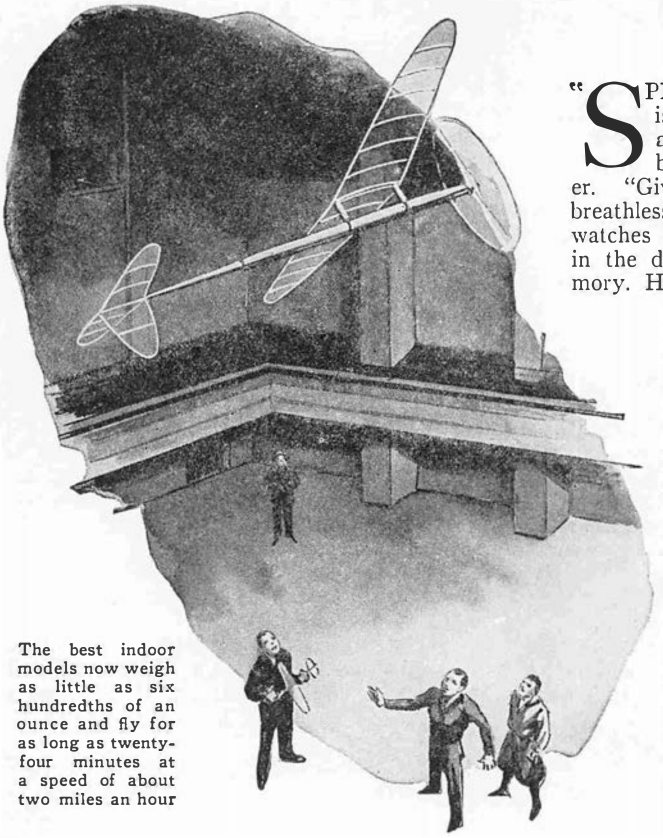
The case shown in the accompanying illustration is a typical example of a converted aquarium for such purposes. The case with glass cost only $5.50 as compared to an outlay of $9, had the frame been welded in a welding shop and the glass purchased separately.

These cases come in a large variety of sizes, and the only alteration necessary is the attachment of a suitable plywood bottom and cover. Small display lights may be installed and the bottom finished in a decorative manner. If boat models are to be placed in the cases, a background may be made of a water scene. If airplane models are used, the background may comprise a flying-field scene or clouds.



Many model makers dread having to make glass cases, but they can avoid the work by buying an inexpensive aquarium like that shown

Secrets of Constructing an Ultramodern



The best indoor models now weigh as little as six hundredths of an ounce and fly for as long as twenty-four minutes at a speed of about two miles an hour

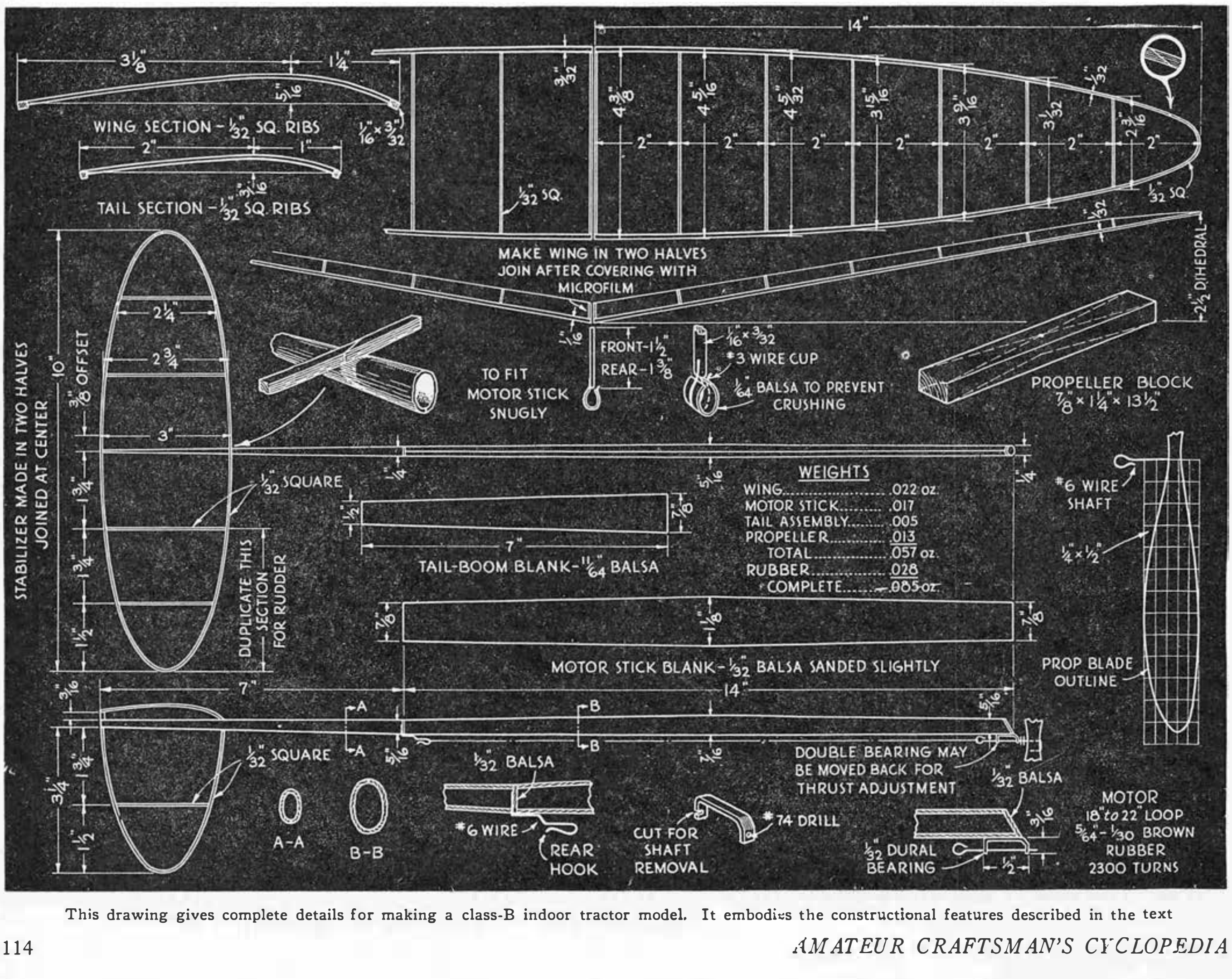
"SPEED and more speed" is the cry of the modern aeronautical engineer, but not the model builder. "Give me slowness!" he breathlessly demands as he watches his ghostlike model fly in the dimness of a silent armory. He talks in terms of two miles an hour while the engineer scorns two miles a minute.

The average speed of an indoor model has dropped from five miles an hour in 1927 to about two at the present time. And the endurance of the flight has jumped from three minutes to twenty-four. The chances of breaking a world record are much better with a slow model because the speed depends on how fast the propeller is turning, and since the number of turns that can be placed in a rubber motor is limited to about 2,300, it can readily be seen that the power must be conserved by slow-turning propellers.

Another factor is lightness. The early designs weighed about .25 oz. while present models of approximately the same wing area weigh only .06 oz. Four times lighter!

To make a model light and strong enough to take care of rubber motor torque and necessary handling, the model builder takes advantage of several structural combinations. The spars are made so that the widest part takes the load. Wherever possible, the wood members are made of balsa tubing having a wall thickness of from 1/32 to 1/64 in. The ribs of the wing and tail are cambered to obtain better lift and to take advantage of the fact that a slightly concave section is stronger than a flat one.

The balsa wood used on indoor models must be of the lightest stock obtainable—not more than 5 lb. a cubic foot. It should be cut along specific grain lines to take advantage of its natural qualities. Wood cut parallel with line *A-A* in the accompanying diagram of a log cross section can be easily bent for motor sticks and other tubular parts because the texture is of the same year's growth and

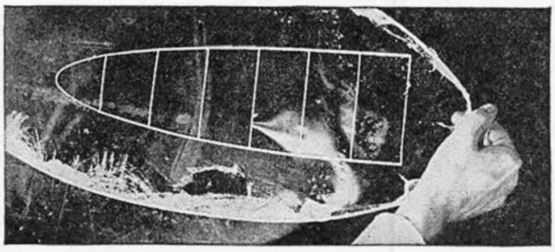


WING SECTION - 1/32" SQ. RIBS
TAIL SECTION - 1/32" SQ. RIBS
14"
3 1/8"
1 1/4"
MAKE WING IN TWO HALVES JOIN AFTER COVERING WITH MICROFILM
2 1/2" DIHEDRAL
FRONT - 1 1/2" REAR - 1 3/8"
1/16" × 3/32"
#3 WIRE CUP
1/64 BALSA TO PREVENT CRUSHING
TO FIT MOTOR STICK SNUGLY
PROPELLER BLOCK 7/8" × 1 1/4" × 13 1/2"
STABILIZER MADE IN TWO HALVES JOINED AT CENTER
3/8" OFFSET
1/32" SQUARE
DUPLICATE THIS SECTION FOR RUDDER
TAIL-BOOM BLANK - 11/64" BALSA
WEIGHTS
WING .022 oz.
MOTOR STICK .017
TAIL ASSEMBLY .005
PROPELLER .013
TOTAL .057 oz.
RUBBER .028
COMPLETE .085 oz.
#6 WIRE SHAFT
1/4" × 1/2"
MOTOR STICK BLANK - 1/32" BALSA SANDED SLIGHTLY
PROP BLADE OUTLINE
A-A
B-B
1/32 BALSA
#6 WIRE
REAR HOOK
CUT FOR SHAFT REMOVAL
#74 DRILL
DOUBLE BEARING MAY BE MOVED BACK FOR THRUST ADJUSTMENT
1/32 DURAL BEARING
MOTOR 18" to 22" LOOP 5/64 - 1/30 BROWN RUBBER 2300 TURNS

This drawing gives complete details for making a class-B indoor tractor model. It embodies the constructional features described in the text

Indoor Plane Model

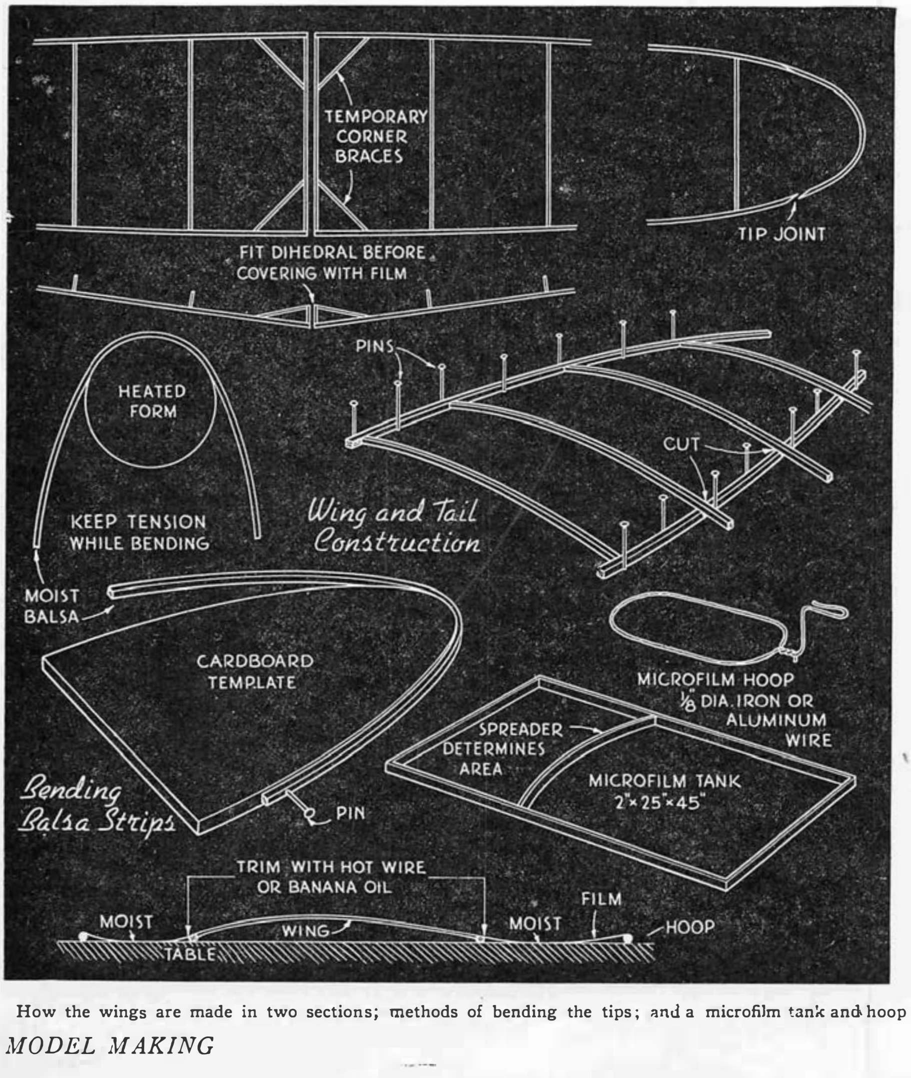
How to make featherweight balsa tubing . . . propellers so thin you can read print through them . . . matched wing spars . . . and microfilm measured in hundred-thousandths of an inch



Lifting microfilm from the surface of a tank of water with a wire hoop. *At left:* Covering a wing with the unbelievably thin cellulose

therefore very even. All that is needed is a hardwood form of slightly smaller size than the finished article, around which the moistened and outlined balsa sheet is shaped and held in place with cotton gauze. To hasten evaporation, the form is placed in a preheated oven for about ten minutes, but be sure that the gas is turned off or very low. Remove the balsa from the form and cement the seam.

Sheets cut on line *C-C* in the log diagram have laminations of several years' growth and are comparatively stiff. They are especially suitable for making cut ribs. Such ribs are stiff and keep shape, whereas bent ribs slowly lose their shape.


TEMPORARY CORNER BRACES
TIP JOINT
FIT DIHEDRAL BEFORE COVERING WITH FILM
PINS
HEATED FORM
CUT
KEEP TENSION WHILE BENDING
Wing and Tail Construction
MOIST BALSA
CARDBOARD TEMPLATE
MICROFILM HOOP 1/8 DIA. IRON OR ALUMINUM WIRE
SPREADER DETERMINES AREA
MICROFILM TANK 2"×25"×45"
Bending Balsa Strips
PIN
TRIM WITH HOT WIRE OR BANANA OIL
MOIST
WING
TABLE
MOIST
FILM
HOOP

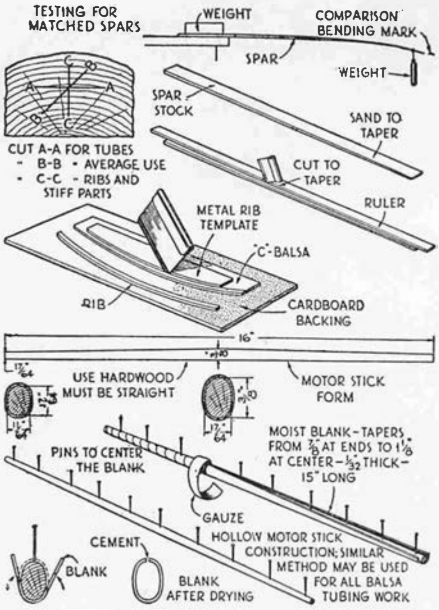
How the wings are made in two sections; methods of bending the tips; and a microfilm tank and hoop

The cut marked *B-B* is all-around stock. It can be used for spars, tips, and other items.

The simplest method of making tapered spars is to taper an entire sheet by sandpapering. Gradually edge towards one end after every stroke, and also regulate the pressure on the sandpaper block—light on the high side and hard on the tapered portion. Use medium sandpaper followed by 10/0 for finishing The spars are cut from the tapered sheet by measuring the width on each end and connecting the points. While cutting, press hard against the steel ruler to make sure that the wood does not creep. Match the spars both by weighing and by holding the thick portion on table and suspending a weight from the tip as shown. Equal weight and bend mean matched spars.

The wing and tail surfaces are assembled on a full-sized plan drawn with the outside dimensions only. Pins are pushed in the baseboard at the points where spars and ribs meet to hold the spars to outline. Hold the spars against the pins with other pins, and also set them at the required angle to conform to the rib flow. The ribs are cemented to the leading edge first. After the cement has set, they are fitted and cemented to the rear spar. If the wing has an elliptical or other curved form, moisten the spars so that they will keep shape when removed from jig.

In the early days it was difficult to make curved balsa tips, and 0.01-in. round bamboo was used. The weight saved by using balsa curves will, however, add a few more seconds to the record time. The wood strip must be of straight grain and cut. Soak it in water until saturated and bend it over a hot form while under steady tension. For circular shapes, an electric soldering iron, hot pipes, and electric bulbs will do. Bend slightly more


TESTING FOR MATCHED SPARS
WEIGHT
COMPARISON BENDING MARK
SPAR
WEIGHT
SPAR STOCK
SAND TO TAPER
CUT A-A FOR TUBES
- B-B - AVERAGE USE
- C-C - RIBS AND STIFF PARTS
CUT TO TAPER
RULER
METAL RIB TEMPLATE
"C"-BALSA
RIB
CARDBOARD BACKING
16"
USE HARDWOOD MUST BE STRAIGHT
MOTOR STICK FORM
MOIST BLANK-TAPERS FROM 7/8" AT ENDS TO 1 1/8" AT CENTER-1/32" THICK-15" LONG
PINS TO CENTER THE BLANK
GAUZE
CEMENT
BLANK
BLANK AFTER DRYING
HOLLOW MOTOR STICK CONSTRUCTION; SIMILAR METHOD MAY BE USED FOR ALL BALSA TUBING WORK

How to select, cut, and test balsa, and methods of making a tapered tubular motor stick

than required to allow for the comeback. For irregular curves a cardboard form is used. Pin one end of the strip to it and, while keeping a steady tension, roll the strip around the form. Pin the free end, and hold the assembly over heat until the balsa has dried. Use tapered joints when cementing tips to spars.

The wing is made in two sections to facilitate covering with microfilm. One section is raised on end to the proper dihedral dimension while the center ribs are cemented. Place temporary corner braces as shown to keep the ribs in place while covering. The braces are removed after the two halves are joined.

A WELL-CARVED indoor propeller always surprises the uninitiated. A propeller having a diameter of from 15 to 16 in. is carved so thin that type can be read through it! Its weight is under .02 oz. The thickness tapers from 1/16 in. at the hub to 1/64 in. at the tip.

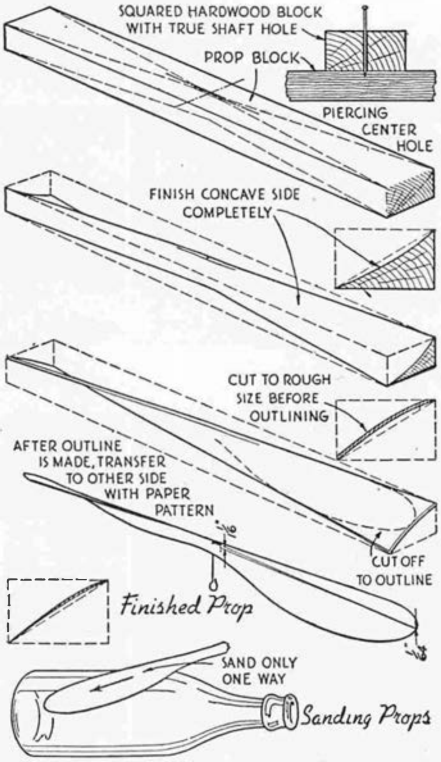
The wood used for propellers should be of 4-lb. grade and of even texture. Cut out the block and pierce the shaft hole with a drill press, or make yourself a squared hardwood block with a true center hole to serve as a drilling guide. The pin is guided in this hole while piercing the blank. Shape the block into an X-blank with about 3/32 in. thickness at the hub. Carve the concave side first. Be careful not to take too big cuts when approaching the pitch line, and also try to get an airfoil concavity instead of just any camber.

After the approximate shape is carved with the knife, finish the concave side with rough sandpaper and for final work use the 10/0 grade. The concave side should be completely finished so that the convex side can be carved to match it.

The outside can be carved with the knife until the blades are only 1/16 in. thick. Now cut one blade to outline shape, and make the other blade identical by transferring the outline on a paper template. From now on it is just a matter of patience until the prop is sanded to paper thickness. Try to have the hub about 1/16 in. thick and gradually taper the prop, to obtain a cantilever effect, to less than 1/64 in. at the tips. The sanding should be done with several grades of paper, each finer than the one before. Sand in one direction only. To insure even sanding, hold the blades on a broomstick or a quart-size bottle. As the blades get thinner, hold them against the light and look for thick portions.

BALANCE the prop in still air by inserting a fine wire in the shaft hole. If one blade is heavier, always feel the thickness to find where the extra weight exists, and also where it can be most easily spared. The leading edge should be thickest because it takes most of the shock.

Now comes the most interesting part—covering the framework with microfilm. Microfilm solution is made from clear commercial lacquer mixed with 1/10 oz. of castor oil to 1 oz. of lacquer by volume.


SQUARED HARDWOOD BLOCK WITH TRUE SHAFT HOLE
PROP BLOCK
PIERCING CENTER HOLE
FINISH CONCAVE SIDE COMPLETELY
CUT TO ROUGH SIZE BEFORE OUTLINING
AFTER OUTLINE IS MADE, TRANSFER TO OTHER SIDE WITH PAPER PATTERN
CUT OFF TO OUTLINE
Finished Prop
SAND ONLY ONE WAY
Sanding Props

The steps in carving a paper-thin propeller. Much of the work is done with fine sandpaper

Banana oil and flexible collodion, when mixed with castor oil, will also give satisfactory results. However, clear lacquer is preferable since it already contains other ingredients that strengthen the film. Be sure to mix the solution well. Heating the container by holding it under hot water helps to obtain a better mixture, but never heat it over an open flame because lacquers are very inflammable.

THE film sheets are made by pouring a short, steady stream of the solution on the surface of perfectly clean and tepid water. The solution bottle should be held just above the surface to prevent splashing. The water may be contained in a half-filled bathtub, or a special wooden tank 2 by 20 by 40 in. may be made. Since lacquer and water do not mix and the lacquer solidifies the moment it touches water, a very thin film is made. The surface tension prevents it from sinking. The slightest trace of soap in the water breaks up the surface tension and the solution does not spread. It is also hard to obtain a satisfactory film if the water is cold. The normal temperature is 75 or 80 deg. F. Since the strength of the film depends on its thickness, it is necessary to make several trial sheets to determine the working conditions.

The average thickness of the film is about 0.00004 in., so it must be applied by methods that require the least possible handling. It is now possible, in fact, to avoid touching it during the whole course of making and using the material.

THE film is removed from the water with a large hoop of 1/8-diameter aluminum or iron wire. This should be large enough to accommodate the wing with several inches to spare on each side. After the solution has spread, it should be allowed to set for about five minutes. The hoop is then lifted from underneath until it touches the film evenly on its entire perimeter. Continue the upward motion until the hoop is about 1/8 in. above the water. With the free hand, gather against the wire the film fringes. Then by lifting one side first, remove the film from the water by a sidewise angular movement of the hoop. Hang the film in a dust-free place and allow to dry.

The microfilm is transparent and sparkles. It is so thin that white light is broken up and refracted in spectrum-color wave lengths. This color refraction is one way of judging the film thickness. The shorter the wave length, the thinner is the film. Violet is of short wave length, and sheets having this color are used for small surfaces. Red has a much longer wave, and red film is consequently thicker. A good rule to follow is to use violet for small surfaces and apple green for wings.

THE simplest method of applying microfilm to the wing or tail is to moisten the spars and the center rib and tips with saliva, which acts as adhesive. Then lay the frame on the table and moisten the area around it with a wet rag. The film hoop is centered over the frame so that the best part of the film is used, and brought down and pressed against the table. The film will stick to the moistened area and draw down snugly against the framework, thus giving the saliva a chance to hold. The film can now be patted against the spars to insure perfect contact and left to set for about half an hour. Benzine-thinned rubber cement may be used instead of saliva as an adhesive, but since it is heavier, it should be used only when saliva fails.

The film is trimmed with a hot wire or an acetone-moistened stick. Keep the trimmer about 1/4 in. away from the spars to prevent the film from melting over them. Be sure that the wire is reheated as soon as the film drags.

The tail surfaces can be cemented to the tail boom after they are covered. The wing is assembled by cementing the center portion of the rib first. After the cement has set, the spars can be brought together and cemented. This will give a neat center joint. Care should be taken when cementing near the film, because it is very easy to melt it.

Occasionally the film becomes wrinkled, either with age or careless construction. It can be smoothed by passing underneath it a hot object, which will tighten the film.

In transporting microfilm models, the film parts should be held in the box with very thin, soft paper, crinkled to prevent it from sticking to the film. Fasten it lightly on both sides of the wing with tacks. Also be sure that the part so fixed is not under strain.

Before flying the model, check the whole assembly for possible warping. The test flights should begin with about 300 turns. Gradually increase the number until the model is just below the girders or ceiling. For a longer duration in a large armory, the model is released as soon as the rubber is wound to its capacity, but in a small hall it is necessary to let out several hundred turns to use up the initial powerful torque.

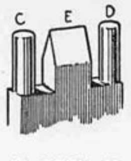
ORDINARY BAR CLAMP APPLIES PRESSURE TO BREAST DRILL

IF YOU find it difficult to drill a hole through soft steel with a breast drill, use an ordinary cabinetmaker's bar clamp to apply extra pressure. The work placed at the edge of the bench, and the breast drill set up in the correct position, with a rubber pad on the breastplate. The jaw at the adjusting-screw end of the clamp is set on the pad, and the other jaw is moved up to grip the underside of the bench directly beneath the work. The drill frame is wired loosely to the bar of the clamp to keep the drill upright. Then, while the drill is turned with one hand, pressure is applied by turning the clamp handle with the other hand, feeding the drill into the work.

GRAPHITE AS LUBRICANT HAS MANY SHOP USES

ONE of the most useful nickel's worth the home workshop owner can buy is a stick of bicycle-chain graphite. This may be applied to any part requiring lubrication where oil or grease would be undesirable. Some of the places where it is effective are: cross slides and lead screws of lathes, lathe chucks, vises and C-clamps, blade guides of jig saws and band saws, table-tilting and raising mechanisms of bench saws, and exposed gears; in fact, any parts that are likely to pick up dirt and grit if lubricated with oil. Graphite is also better than oil for lubricating lathe centers.

Tiny Turnbuckles for Model Use



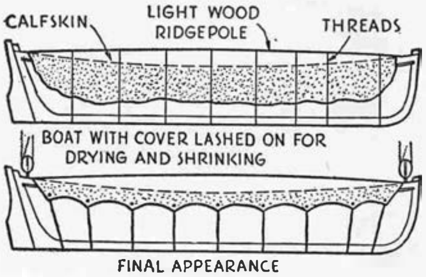
Enlarged view of brass form

TO MAKE miniature turnbuckles in quantity, take a piece of sheet brass about 1/16 in. thick and cut it to a width equal to the length of the desired turnbuckle; then file *E* as shown and round *C* and *D*. Hammer some small copper wire slightly to flatten it and wind it in and out through the slits. Remove the bent form, cut off the excess wire, hammer both end loops flat, and solder.

Realistic Lifeboat Covers Cut from Calfskin

REALISTIC covers for the lifeboats on model steamships may be made from sheepskin or calfskin of the kind used for the heads of drums or banjos. The broken heads can be obtained for next to nothing at any music store where instruments are repaired.

Cut the pieces to the correct length and a little wider than the boat to be covered. Soak them in warm water until soft and pliable, wipe dry with a cloth, and hold in position on the boat by wrapping with thread. Place on the back of a stove or on a radiator overnight to harden and dry. Then cut the covers to the proper shape with a sharp knife or small scissors. Burn the holes with a hot needle or wire of the right size and sew in the cords that hold the covers in place. No paint or finish is needed as the color is a perfect imitation of canvas.



After the cover has been shrunk, the edges are cut to imitate very tightly pulled canvas

Small Electric Motor Constructed from Old Auto Cut-Out

VERY small electric motors for experimental purposes or use in models can be made from discarded automobile generator cut-outs. They cost only about seven cents apiece—for wire and solder, provided you can get the cut-outs for nothing. Any make or style can be used, but it is easier to work with them if the coil is bolted to the base rather than riveted and if one or both of the point supports can be used for bearings. The inside bearing of the motor illustrated was originally the point support.

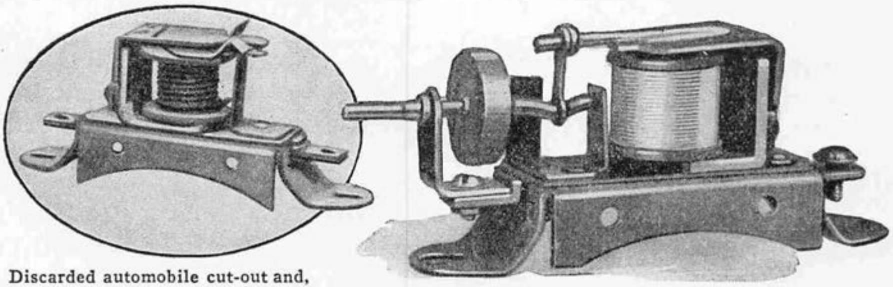
Coil. Remove armature and take coil from base. Remove both windings. Rewind evenly with about 300 turns of No. 24 magnet wire. Cut the point supports to size for bearings if you can use them; otherwise cut them clear off.

Armature. Remove everything but the hinge spring from armature and cut it off even with edge of coil. Flatten one end of a ⅛-in. steel rod and solder on top to take connecting rod. The length of this piece is determined by the most convenient place for the crankshaft dip.

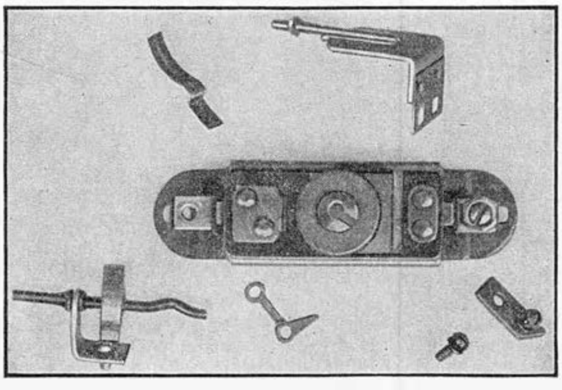
Crankshaft. Use same size rod and bend evenly. A dip of about 3/32 in. giving a 3/16-in. stroke is best. Make half a dozen, if necessary, and select the best.

Bearings. If you can't use point supports, make them of light sheet metal. The design will vary with the type of cut-out. On most cut-outs, at least one bearing can be used.

Flywheel. Punch from 3/16-in. sheet lead and solder on crankshaft. This is easier and quicker than casting, but if no sheet lead is at hand, cast it on crankshaft. The best diameter for most cut-outs is ¾ in.



Discarded automobile cut-out and, right, tiny motor made from it



The motor disassembled, showing the few and simple parts

Connecting rod. This also serves as the timer and is made L shaped. No specific size can be given, but the shape can be seen in photograph of disassembled motor.

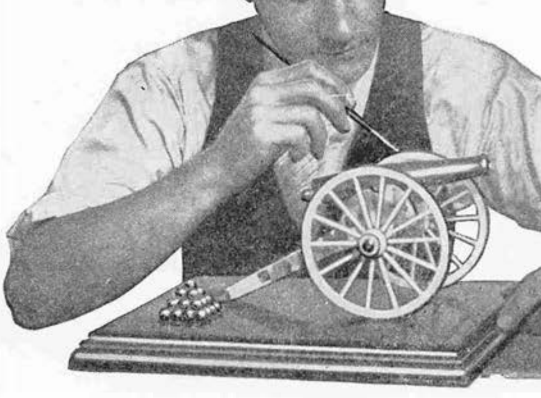
Brush. This must intercept connecting-rod point just as crankshaft leaves dead center on power stroke; and the connection must break before stroke is completed, but not too soon. Find correct adjustment by experiment. Use thinnest spring steel obtainable or find a section of very small clock spring with a curve corresponding as closely as possible with curve of timer point and cut it from spring with enough extra to fasten to a support. This brush must be entirely insulated from crankshaft and magnet core. Hold it with pliers and heat the entire lower or supporting part—not the curved contact part until it glows red. Let it cool slowly. It will then be pliable enough to be adjusted to suit the timer.

Collars may be needed to keep connecting rod and crankshaft in place, taking up end play.

Wiring. Connect one end of coil with either main bearing, and the other to one side of current source. The other line goes to the brush.

HISTORIC Gettysburg

How to Construct a Scale Model



The gun which this little model represents stands today in its original position on Barlow's Knoll

EVERY model builder who is interested in old cannon or in the Civil War will want to add to his collection this accurate model of one of the guns preserved on the Gettysburg battlefield. The model is made on a scale of 3/32 in. equals 1 ft., and is 11⅝ in. long. It is mounted on a mahogany base 10 by 13 in.

This particular gun stands on Barlow's Knoll, where Battery G, Fourth United States Artillery, was stationed under the command of Lt. Bayard Wilkeson. The fire of thirty-six Confederate cannon was turned on this position. Wilkeson's leg was almost severed by a shell, and he completed the amputation with his own hands and a penknife. The knoll was finally captured, and during the night Wilkeson crawled back to the Almshouse buildings, where he died.

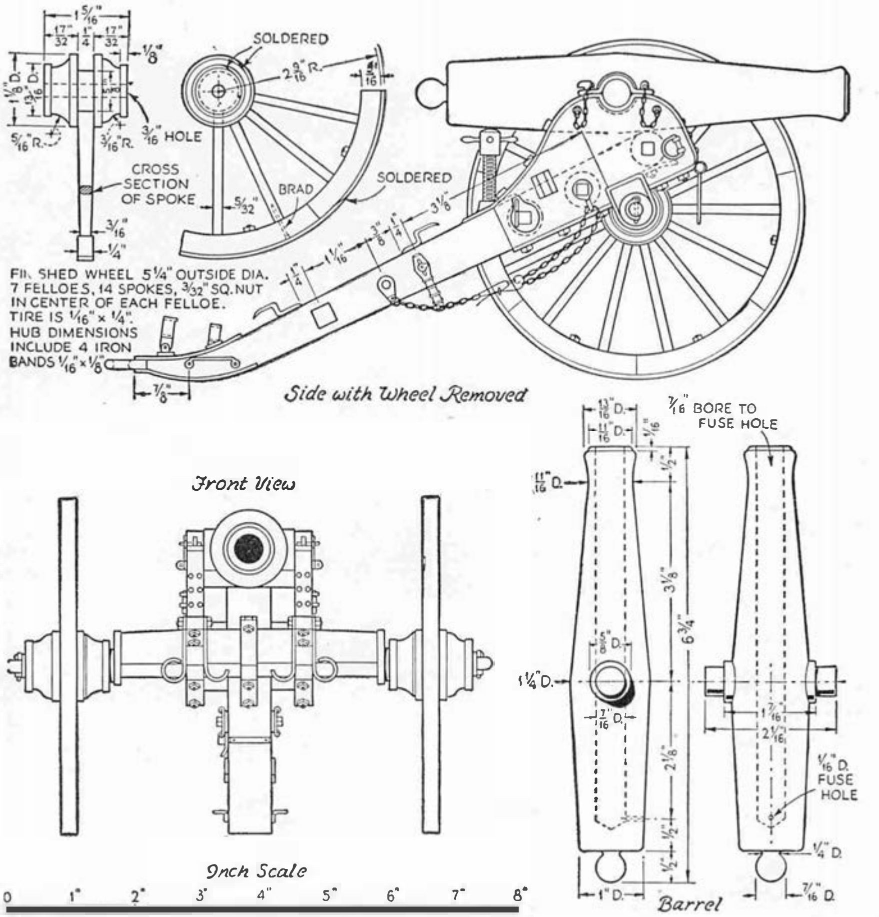
The wheels of the model are not dished, but flat. The felloes are cut in one piece from ¼-in. plywood (or you can make seven felloes, if you prefer). The spokes are 5/32 in. thick and taper in width from ¼ in. at the hub to 3/16 in. at the rim. They are rounded as shown except for the ¼ in. that extends into the hub.

The hubs are turned in one piece and banded with four metal bands ⅛ in. wide and 1/16 in. thick. The dimensions given for the hubs include the 1/16-in. thickness of the bands. It will be well worth the extra time it takes to bush the hubs with 1 5/16-in. lengths of 3/16-in. inside diameter tubing.

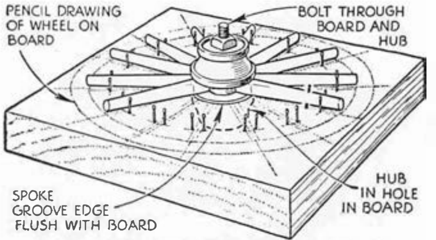
Make a jig by laying the wheel out on a board and boring a 1⅛-in. hole 17/32 in. deep to hold the hub's ¼-in. spoke groove flush with the surface of the jig. By drilling a 3/16-in. hole the rest of the way through the jig, the hub can be bolted firmly in place. Drive small brads in the jig on each side of the spokes about ¼ in. from the circle where the spokes meet the rim. Now tap the spokes in place in the hub and let the ends rest between the brads. Drill small holes through the felloes and into the spokes for ½-in. brads.

The tire should be pressed on while the wheel is still on the jig. The tires can be made of 1/16 by ¼-in. strips of metal by filing a ½-in. taper on each end and soldering the tapers together. The small 3/32-in. square nuts in the center of each felloe are made of cardboard and glued in place.

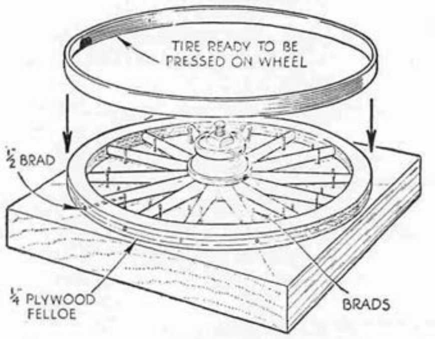
The wooden part of the axle is ½ by 9/16 by 4¼ in. The 9/16-in. side is tapered on each end to ½ in. square at the ends, leaving a 2-in. flat surface at the top for the two sides and the tongue to rest



Side and front views of the model, and details of the wheels and gun barrel, with a scale in inches


PENCIL DRAWING OF WHEEL ON BOARD
BOLT THROUGH BOARD AND HUB
SPOKE GROOVE EDGE FLUSH WITH BOARD
HUB IN HOLE IN BOARD

How Wheels are Assembled



The correct way to make the felloes is to use seven pieces, but it is simpler merely to cut a one-piece ring from ¼-in. plywood

Cannon REPRODUCED IN MINIATURE

of a Picturesque Civil War Gun

on. The underside has a 3/16 by 3/16-in. slot or groove running its entire length to accommodate the square part of the metal axle, which is merely a 7⅝-in. length of 3/16-in. square rod turned or ground to 3/16 in. round where it extends past the wood. The tips also are rounded on the ends. The wood and iron part of the axle are held together by a ⅛ by 1/16-in. band on each end of the wood, filed from a piece of ⅛-in. metal.

Pins for retaining the wheels in place are 1/16-in. roundhead rivets with two sides of the head filed flush with the shank. The locking strip is cut from 1/32-in. sheet metal; it is 1/16 in. wide and slightly larger and rounded at the end where it is riveted to the pin. Rivets may be made from ½-in. pins cut off to the desired length. The ½ by 1/16-in. washers go behind the wheels, and the ⅜ by 1/16-in. washers go between the wheels and the locking pins.

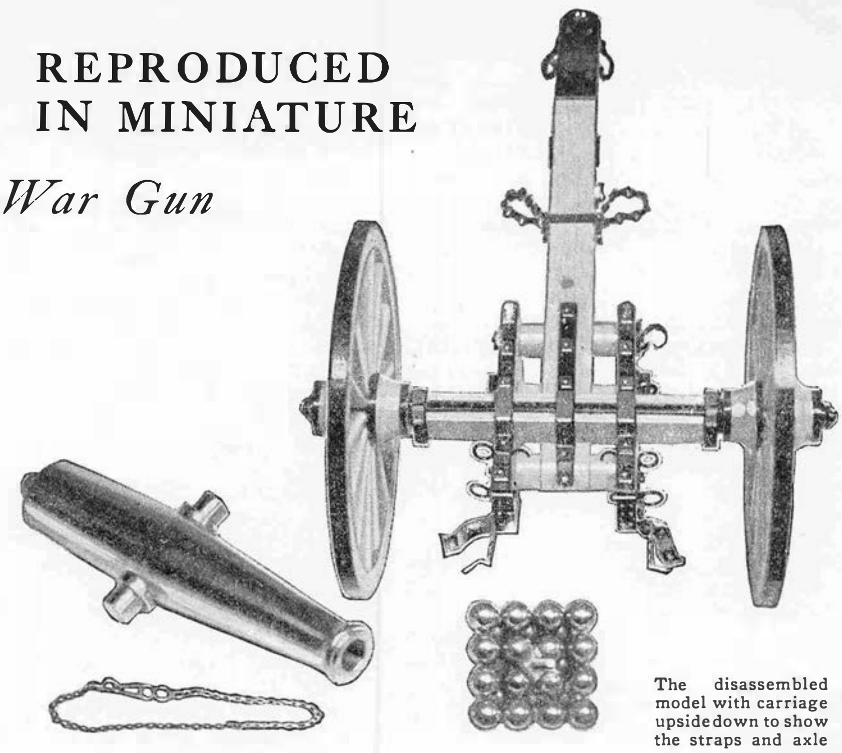
The tongue is 11/16 in. thick. Cut it to the shape shown, being very careful to have the ¼-in. offset at the head square with the sides. Also drill the three holes for No. 4 bolts exactly square with the sides of the tongue.

Next drill and file the towing ring to the shape shown from a 11/16 by 11/16-in. square of ⅛-in. metal. The top and bottom plates are 1/16-in. sheet metal bent to shape and riveted to the ring by two 1/16-in. rivets, countersunk at top and bottom.

The two blocks with the tapered rings can be made as follows: First prepare the flat bases. Then solder two ⅛ by ⅛-in. lugs, rounded at the top, to the block nearest the ring. Now put the towing ring and plates in position on the tongue, clamp the two small blocks on the top plate, and drill a 1/16-in. hole in each end of both blocks. These holes are drilled all the way through the top and bottom plates. The 1/16-in. roundhead rivets that hold the blocks in place also hold the top and bottom plates in position on the tongue. The bottom plate is countersunk. To hold the ring and plates tight against the wood while drilling, run a piece of wire through the ring and around the end of the tongue and draw it tight with a small turnbuckle.

THE tapered rings can be shaped by bending metal strips around a tapered stick, and filing them to the desired shape. Leave an extension on the largest ring to be pinned between the lugs on the block. This completes the larger ring, and the smaller ring can now be soldered by holding it in place with a tapered stick passed through the larger ring.

For lifting, make the grips of 1/16-in. wire bent to shape and hammered flat on the ends, where they are drilled and fastened to the wood by small brads. The two cleats, clip for the chain ring, and rub plates are made of 1/16-in. sheet metal and fastened as shown in the side view.

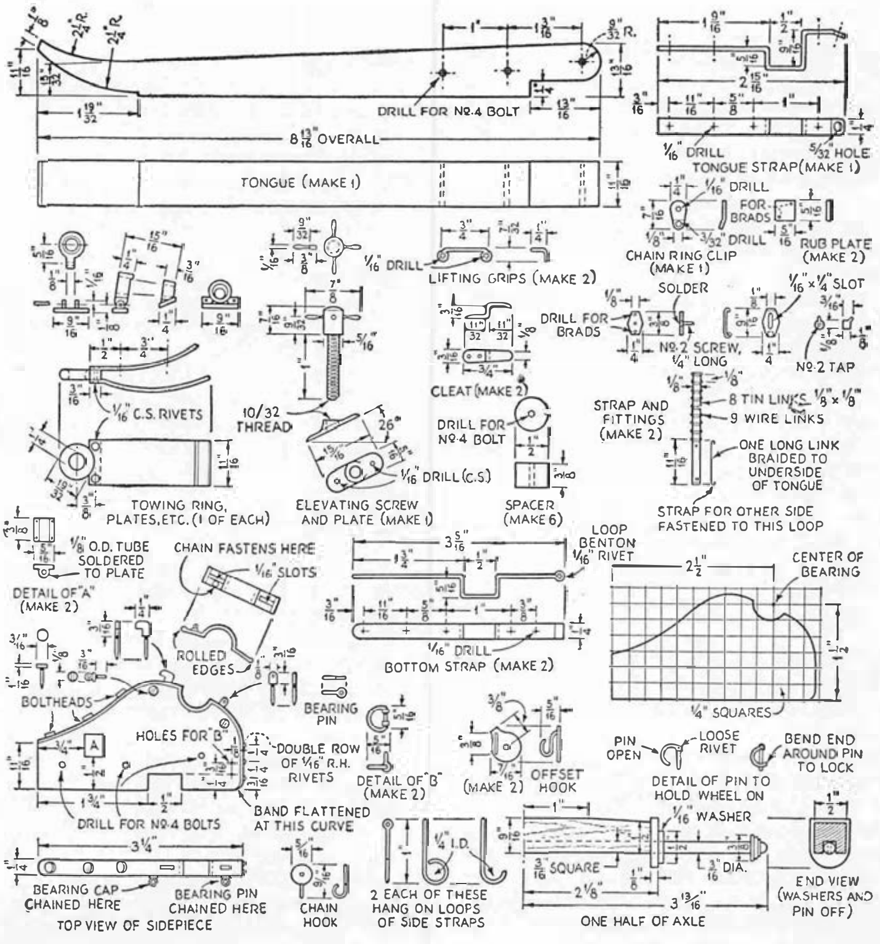


The disassembled model with carriage upside down to show the straps and axle

The cleats are bradded in the center of the tongue. The rub plates are bradded in place also. The chain-ring clip has a small washer slipped over the brad to represent a large round flatheaded pin.

Wherever brads are used, the heads should be sunk below the surface of the metal and filed flush.

The strap plate, which has a No. 2 countersunk screw extending from its surface, is 1/32-in. metal, fastened on the tongue with small brads or escutcheon pins.



Working drawings of the tongue, sidepieces, bearings, axle, straps, and all the smaller fittings

The slotted piece (also 1/32-in. metal) with the metal strap linked to its looped end is slipped over the screw and fastened by the wing nut. The screw was taken from an old dollar watch, and the nut was also a part of the watch filed down to ⅛-in. with a small piece of metal soldered to it to serve as a wing. The strap is made of wire links holding the ⅛-in. square tin links together, each link having the ends bent over a piece of wire to form a loop at each end. The top loop of each link is bent out, and the bottom link is bent in the opposite direction. The long link that is bradded to the underside of the tongue has a loop on both ends to hold the straps for both sides of the tongue. All the fittings are duplicated on both sides of the entire carriage except the chain, the hook near the axle, and the clip for the chain ring.

The tongue strap (1/16 by ¼-in. metal) is bent around the axle and drilled as shown. To make this look as though it is bolted on, make ⅛-in. squares of 1/16-in. metal, drill 1/16-in. holes in the center, and nail them in place with 1/16-in. roundhead rivets or escutcheon pins. By drilling holes in the wood slightly smaller than the rivets or pins, the imitation bolts can be driven without danger of splitting the wood.

The elevating screw is made by soldering a tube 7/16-in. long around the end of a 1½-in. No. 10 machine screw and drilling four 1/16-in. holes evenly spaced around the circumference for the grips or handles, which are ⅜-in. lengths of 1/16-in. wire filed to shape in a lathe chuck. The plate can either be built up by soldering a piece of metal to the 1/16-in. plate or filed to shape from a solid piece of ¼-in. stock. The solid piece is best as it will not come apart when drilled and tapped to fit the No. 10 screw. The angle can be obtained by laying the plate in place on the tongue and filing the round center part to horizontal. The plate is best drilled and tapped after being nailed in place so that its center is ⅝-in. from the flat end of the barrel when the barrel is raised to its highest plane.

The sides of the carriage are cut from ¼-in. wood, and rounded at the rear. These sidepieces are banded with 1/16 by ¼-in. strips of sheet metal as shown. The top is held in place by imitation boltheads made by cutting flathead nails off short and filing the heads down to 3/16-in. diameter in the lathe chuck. The front end is held in place by six 3/16-in. roundhead rivets. (See front view.) The band is flattened at the end where it bends around the ⅛-in. radius at the bottom. The rear ends of the top and bottom bands are rounded the same as the wood.

The bearing caps are metal strips 1/16 by ¼-in., bent around a piece of **7/16-**in. round stock to form a semi-circle, and the ends are bent out and cut off ⅜ in. from the inside edge of the circle to form caps measuring 1 3/16 in. from end to end. The rounded ends of the caps can be made by soldering small pieces of wire across each end and filing to the desired shape. Each end of the bearing has a 1/16 by ¼-in. slot cut in it to fit over the hook-and-eye lugs, which are filed to the shape shown from 1/16-in. sheet metal and put in place by drilling 1/16-in. holes through the bands and the wood to receive them.

The rings for the chains are made of ⅛-in. round metal filed to shape. One is soldered to each bearing cap and two are driven into each wooden side, just a little below and to the sides of the bearing-cap edges. The caps are chained to the rings below the hook, and the eye pins which project through the caps are chained to the rings below the pins. Four small pieces of chain about 1 in. long are needed. The eye pins are pieces of 1/32-in. wire with a small loop on the end for fastening the chain.

A is a ⅜ by 5/16-in. piece of 1/16-in. metal with a ⅜-in. length of ⅛-in. outside diameter tubing soldered to it. This is bradded in the space indicated on the drawing.

B designates the hand rings on each side of the carriage, which are made of 1/16-in. wire bent to form the letter D and are held in place by two pieces of wire flattened at the end and bent around the straight part of the D to form a hinge. These hinge wires are driven into holes as indicated.

The offset hooks are made by bending 1/16-in. wire to the shape shown and soldering them in the holes drilled in plates of 1/16-in. sheet metal filed to shape and with holes drilled in the center to receive the No. 4 bolts. The chain hook fastened to the No. 4 bolt near the axle is filed to the desired shape from 1/16-in. sheet metal.

Place one side in position on the axle, tight against the tongue, and drill the holes for the No. 4 bolts, using the holes in the tongue as a guide to insure getting the holes in line. Remove the drilled side and repeat the same process with the opposite side.

You are now ready to bolt the sides in place. For bolts use 3-in. nails after filing the heads down to 3/16-in. diameter and threading the ends well back with a No. 4 button die. For nuts use No. 4 hexagon nuts filed square. Put both sides on the axle, leaving a ⅜-in. space between the tongue and the sidepieces. This ⅜-in. space is taken care of by ⅜-in. lengths of ½-in. dowel with a hole drilled in the center so they can be slipped on the bolts and used as spacers. Six of them are needed. The bolts are put in place with the nuts on the right side of the carriage. The front bolt has a small washer under the nut; the chain hook is placed under the nut of the center bolt; and the last bolt has an offset hook on each end.

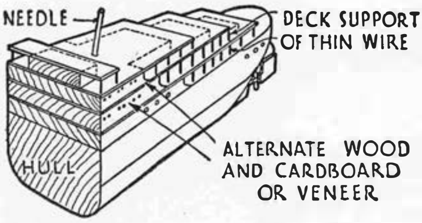
The bottom straps for the sidepieces are put on in the same way as the tongue strap was, using imitation bolt ends with square nuts. The wire loops, which hang on the loops bent on the ends of the sidepiece bands, are fastened with 1/16-in. rivets with a small imitation hexagon nut on each end to represent small hexagon bolts and nuts. These hexagon nuts should not be more than 3/16 in. across the greatest diameter.

The gun barrel can be cast from a wooden pattern, or turned from solid stock on the lathe. The latter method of construction was chosen for the model in the photographs because it is easier to get a good even finish on the metal, especially if the surface is to remain unpainted. To build up the barrel from brass, use 7/16-in. rod for the pivots, turn it down to ¼ in. on the ends, and thread the pieces to fit in holes drilled and tapped in the barrel. The ⅝-in. diameter shoulders on the pivots are brass washers with ¼-in. holes. They must be filed to fit closely against the curved sides of the barrel.

The chain fastens to the clip on the tongue by a small ring. The other end is linked to the hook arrangement shown in the side view. The hook is made of 1/32-in. wire and measures ⅞ in. over all. Another length of chain, both ends of which are linked to the other end of the hook, is hung on the hook just back of the axle.

The pile of cannon balls and the mounting board are optional. The balls are 7/16-in. ball bearings soldered together. It is necessary to make a frame to hold the first layer together while soldering. To fasten the balls to the board, solder a No. 8 machine screw to the bottom of the pile and tighten it down with a nut on the underside. The wheels are fastened to the board by small clips bent over the rim and bolted to the board, and the tongue is drilled and tapped for a No. 8 machine screw, which is screwed into it from the bottom of the board.

All the wooden parts are light gray; the metal parts, black. The barrel in the model illustrated, being brass, was polished and given a coat of clear lacquer.


NEEDLE
DECK SUPPORTS OF THIN WIRE
HULL
ALTERNATE WOOD AND CARDBOARD OR VENEER

HINTS ON CONSTRUCTING MINIATURE LINERS

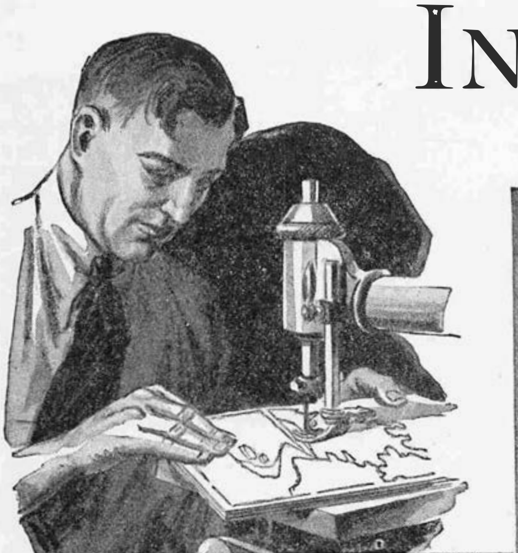
Building small models of ocean liners like the *Queen Mary*, *Bremen*, and *Normandie*, is, perhaps, the type of model-making in which it is easiest to get really good results. As shown in the drawing, decks can be built up of alternate layers of wood and either thin cardboard, wood veneer, or stiff, heavy paper, depending upon the scale of the model. Cut the pieces of wood that represent the decks narrower than usual, but cut the pieces of cardboard, veneer, or paper so that they reach right to the edge of the ship and, if the model so indicates, project a short distance over the end of the thicker wooden piece.

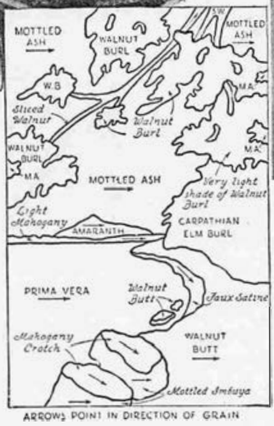
It is advisable to paint the edges of the narrower decks black before putting the paper or cardboard pieces on. Details such as portholes and doors may be indicated, on the black edges with white paint, while thin pieces of wire may be put in along the edges to represent the deck supports, if desired.

Sewing needles make good masts for miniature ships. Beads are useful; they make good crow's nests, winches, and antenna insulators. Portholes and small lettering can be added with an ordinary pen and black and white inks. Rigging of fine silk thread will add greatly to the ship's appearance, and it is easily put on with transparent cement.

WOODWORKING

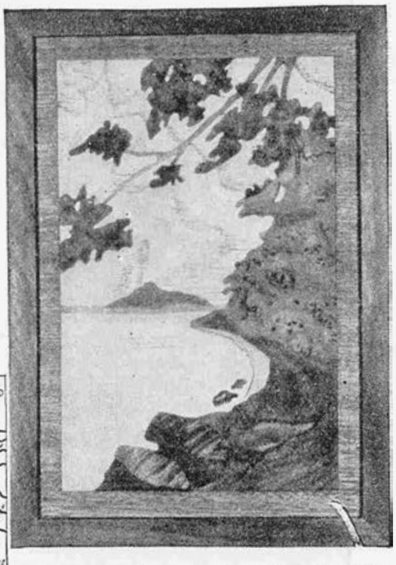
The Art of Making Beautiful INLAID PICTURES FROM WOOD VENEERS





THE WOODS USED

This diagram shows the woods used for the picture. Faux satine is also known as cypress crotch; mottled imbuya as Brazilian walnut; mottled ash as satin ash



"Shady Cove"—a simple but exquisitely colored picture sawed from wood veneers

INTARSIATURA, or the art of making inlaid pictures from fine veneers, is rapidly becoming popular among amateur craftsmen. With the aid of a modern electric jig saw, it is comparatively easy to do, yet the results are attractive and valuable. The materials themselves are comparatively inexpensive, and many dealers now stock a large variety of suitable veneers.

So old is intarsiatura that it was practiced extensively in Italy in the fifteenth century. At that time pieces of the utmost artistry were made with very crude tools and materials. The home worker of today, however, experiences few of the difficulties that confronted old-time craftsmen, and for that reason the art is enjoying a revival.

The tools and materials necessary are a jig or scroll saw, several dozen fine jig-saw blades, a variety of veneers, tracing paper, a few sheets of celluloid or transparent cellulose wrapping material; white, stain-free casein glue; ½-in. gummed paper tape, and some pasteboard. Use a blade .008 in. thick and .028 in. wide with 38 double teeth to the inch. It has a rounded back and is commonly known as No. 38. This blade is a little more expensive than jeweler's blades, but does not break so readily. A few extra fine blades with about 70 teeth an inch are useful for very delicate work.

Landscapes, figure pieces, portraits, conventional ornaments—almost anything that can be painted may be worked out in veneers. It is best, however, to select relatively simple subjects of a type that can be represented by veneers without straining for effect or violating the canons of good taste.

The inlay picture "Shady Cove" shown in the accompanying illustration has been prepared especially as a first piece for beginners. No great accuracy is required either in copying it or in doing the cutting, but all the essentials of the art may be learned by carefully following out the processes required to make it.

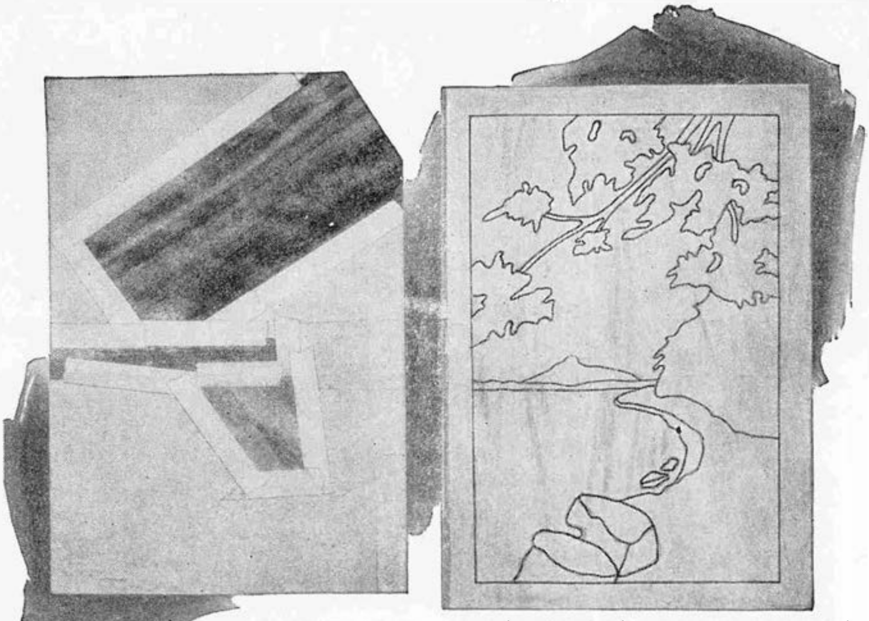
The first step is to prepare a full-size drawing 6 by 9 in. and trace it with India ink on a sheet of cellulose wrapping material. The tracing is to help find appropriate grains and swirls in the veneers to be used. This is done by going over the veneer and looking through the finder to select the part that is best adapted for use in each particular detail of the picture. For insance, in selecting the sky wood for the picture illustrated, the finder was run over a piece of mottled ash to obtain the cloud effect. When selected, the part was marked and cut later. The same procedure was followed for the foliage, water, bank, rocks and bluff, and all other parts. It is through this finder that the various parts are visualized.

After selecting the veneers, cut out enough to allow an overlap of ¼ in. beyond the lines of the drawing. Then take pasteboard the same thickness as the veneer and cut openings into which the pieces of veneer can be fastened in their correct relative positions, as shown in the left-hand illustration on the next page. Fasten the veneer with ½-in. gummed paper tape. The photograph just referred to shows sliced walnut for the tree branches, light mahogany for the horizon, and faux satine for the beach, all taped. The openings, of course, are first marked on the pasteboard by use of the finder.

The object in using the pasteboard is to save veneer and reduce the thickness of the pad to be described later. If one does not care about the expense in waste veneer, the pasteboard may be eliminated and veneer the full size of the pad can be used. The leaves of the pad, whether pasteboard or veneer, should be cut 7 by 10 in., thus allowing a ½-in. margin all around the picture.

THE next move is to cut two pieces of ⅛-in. whitewood to form the top and bottom of the pad. Lay down one piece of the whitewood and pile on this the various leaves, being careful to arrange them so that the saw lines in the drawing will cut through the veneers selected for each part of the picture. When the leaves are all placed, put on the other piece of whitewood to form the top of the pad. Fasten all together by driving brads ¼ in. in from the edge and about 1½ in. apart.

On tracing paper, make a tracing of the drawing and paste this on top of the pad, as shown. All lines are saw lines, and care should be used to follow these with the saw. Drill holes for threading the saw on the edges of the darker wood; these holes are to be filled later with composition wood crack filler. Have the saw blade exactly perpendicular to the saw table. When such fine blades are used, this will give as close-fitting joints as are humanly possible to obtain. Run the saw at a speed of approximately 700 or 800 revolutions, and feed



Left, how the veneer pad is patched with cardboard to reduce its thickness and save expense. Right, the finished pad ready to cut

the work slowly. First saw out the center and the small pieces, taking care that the saw does not pull out and scatter these pieces. It is advisable to use a pointed stick to press down on them just as the saw completes the cut and hold them in place until the saw is stopped. All these pieces are placed in a box lid or shallow box until ready for assembling. The parts along the edges of the drawing are sawed out about ⅛ in. beyond the edge.

When the jig-saw cutting has been completed, clamp a straightedge along the edges of the drawing and saw through the pad with a miter or back saw. Place the parts thus freed in the box lid until all four edges have been sawed. Be sure to cut all four edges square.

Cut a piece of walnut or mahogany 5-ply wood, having one good side, about 1 or 1½ in. larger all around than the drawing, say 9 by 12 in. You are then ready to assemble the picture, and this is done somewhat on the order of a jig-saw puzzle.

Take a piece of fairly stiff wrapping paper and coat one side with rubber cement, such as is used in repairing rubber tires. Assemble and cement the sawed-out parts on this paper, face side of the picture down. Be sure to get the joints as tight as possible. When it is impossible to get a perfectly tight joint, have the open joint next to the darker wood so that it may be filled in later with composition wood crack filler, or a mixture of very fine sawdust and glue to match the dark wood.

When this work is completed, coat the piece of plywood with white casein glue on the inferior side and glue the assembled parts to this, paper side up. Put the assembly in a glue press, or clamp it securely in any convenient way, and leave for twelve hours.

When the work has been removed from the press, take hold of one edge of the paper and pull it off, after which wash off the rubber cement with a coarse cloth and gasoline. Fill in all drill holes and open joints.

The picture may either be framed or made into a plaque, with or without a border according to the craftsman's own ideas.

There are various ways to finish the work, but you will find that the less sanding is done, the more artistic the result. If you wish a smooth, glossy finish, however, start sanding with No. 2/0 garnet paper and finish with No. 6/0. Sand each wood in the direction of the grain and use care not to overlap, as sanding across the grain anywhere will leave some scratches. Then apply three coats of clear lacquer or white shellac, rubbed with very fine steel wool and finally with rottenstone and oil. A simpler and very satisfactory finish may be obtained merely by applying two or three coats of *bleached* linseed oil and rubbing between coats with a soft rag. Each coat should be allowed to stand ten or fifteen minutes, then be rubbed perfectly dry. Wait at least twelve hours before applying the next coat. The more rubbing, the greater the sheen. Bleached linseed oil does not darken the wood like boiled oil.

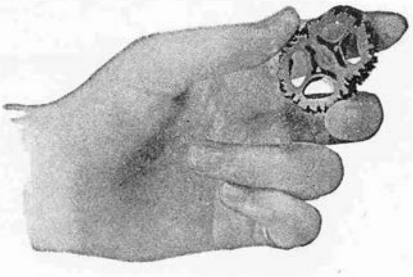
In "wooding," that is, in selecting the different veneers, the light-colored woods are the background, and the pieces gradually become darker until the dark woods form the foreground. For instance, the sky is the lightest in color, and water is a shade darker no matter in what part of the picture. There are also occasional pictures in which the general rule is reversed. Only from experience can one acquire the art of wooding. It is advisable for the beginner, after making the picture "Shady Cove," to purchase designs accompanied by the woods. Two or three such designs if carefully followed, will give considerable practice.

When necessary, veneers may be stained before being cut, but you may never require this artificial aid in making up a picture.

SAFETY PIN SERVES AS COTTER

A CONVENIENT cotter key for experimental work—one that can be inserted or removed with the fingers alone—is found in an ordinary safety pin. When not in use, string the nut on the pin and snap the pin through the hole in the bolt. This keeps the nut and substitute cotter key from getting separated or lost.

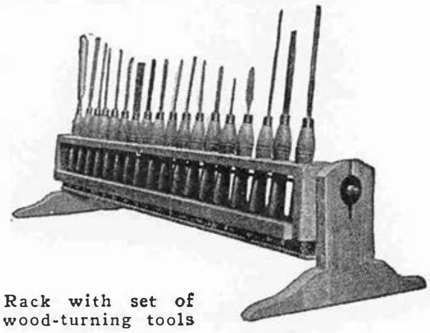
NOVELTY SPORT BUTTONS MADE FROM NUTS



BUTTONS that are especially suitable for sports clothes may be made from nuts such as the American (black) walnut and the hickory nut. All that is necessary is to clamp the nut firmly and cut it crosswise into slices of the desired thickness with a fine-toothed saw. Remove the loose bits of kernel and then sandpaper the button to remove the saw marks. Drill holes for the thread and, if desired, apply a coat of shellac or varnish to protect the surface. Several buttons can be cut from each nut.

The button illustrated was made from the black walnut.

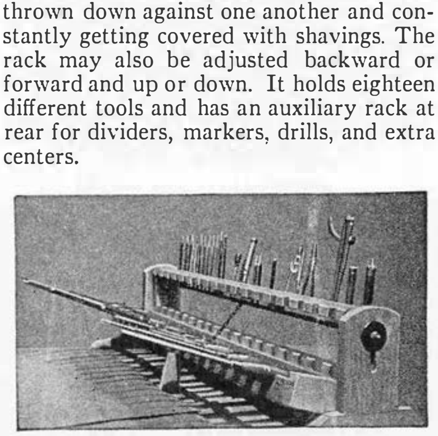
A HANDY TILTING RACK FOR TURNING TOOLS



Rack with set of wood-turning tools

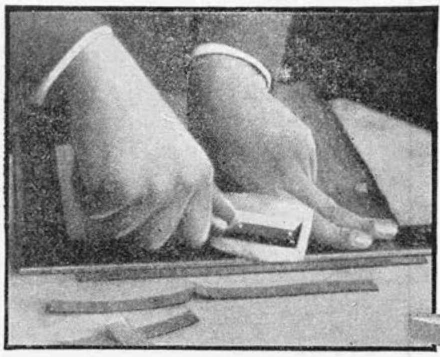
DESIGNED to hold a complete set of wood-turning tools, the rack illustrated can be attached to the wall or set on the bench, just behind the lathe. Most craftsmen prefer to have their lathes placed in front of a window, in which case there is no convenient place to keep the turning tools.

This rack tilts forward to make it easier to select and remove the desired tool and later return it to its place. Therefore the tools are always in place, instead of being thrown down against one another and constantly getting covered with shavings. The rack may also be adjusted backward or forward and up or down. It holds eighteen different tools and has an auxiliary rack at rear for dividers, markers, drills, and extra centers.

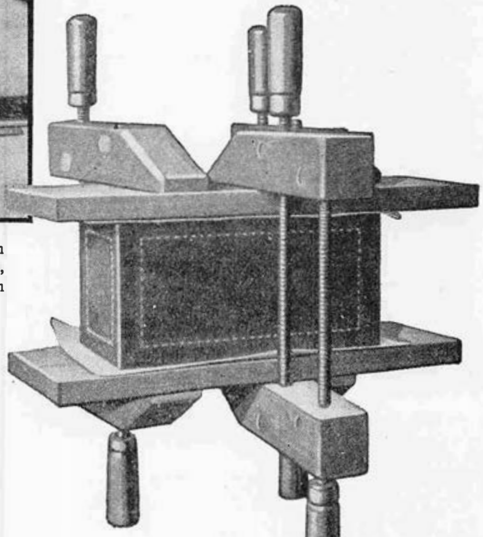


The front part of the rack tilts forward to make it easier to select the required tool

HOW TO MAKE BEAUTIFUL *Veneered Boxes*



Veneers are cut on any flat surface, such as an old drawing board, with a veneer saw, shown above, or a heavy knife or plane iron



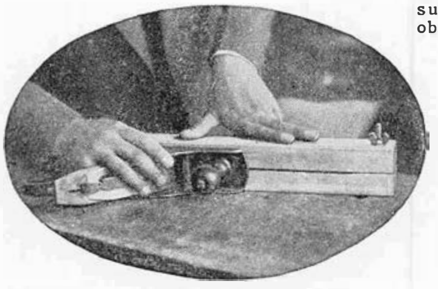
For veneering small boxes, sufficient pressure can be obtained with hand screws

SMALL, decorative boxes made in the home workshop are easily finished by means of veneering. The first step is to get out the material for the sides and ends. Use some softwood as Philippine mahogany, whitewood, or cypress. After being squared, these pieces are veneered on one side so that the grain of the veneer runs at right angles to that of the solid wood. Inexpensive crossbanding, may be used for this purpose.

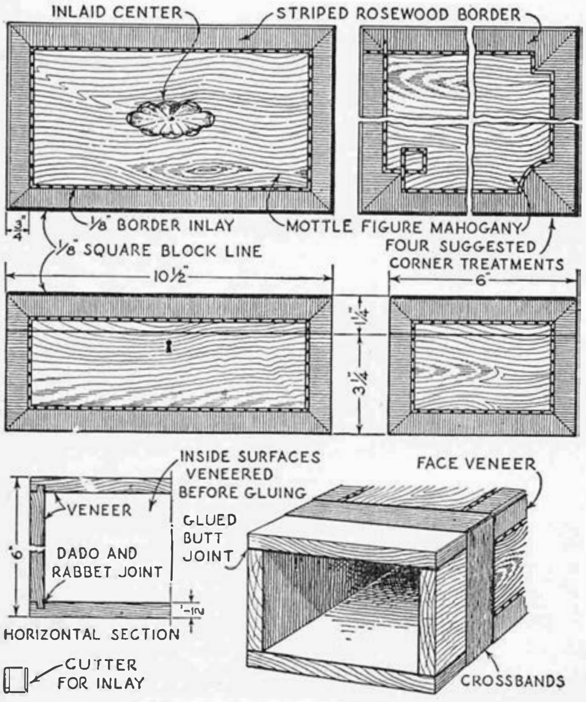
Cut the veneers into strips that are ½ in. wider and longer than the finished dimensions. If two strips must be joined, the edges are planed by clamping them between two hardwood boards. They are then fastened to a board with fine brads and taped together with gummed paper strips.

For gluing, use a stainless casein glue and apply it to the solid wood only. Fasten the veneer with a couple of fine brads and cut their heads off ⅛ in. above the surface. The taped side of a joint should always be up. Cover the veneer with a piece of newspaper and place the other side on top of the first one. Press down on it so that the projecting ends of the brads enter the wood. Glue the veneer to the second side in the same way and clamp the two sides between two straight, soft boards. Veneer the ends in the same way. When dry, remove the brads, trim off the projecting veneer, sand the surfaces, and make the dado and rabbet joints in the corners. Glue the sides and ends together, being careful to check for squareness.

The top and bottom are also veneered across the grain, but on both surfaces of each piece. When the glue is dry, the sides and ends are planed perfectly smooth and crossbanded as explained before. The two sides are veneered at the same time, and then the two ends.



Planing the edges of veneers that are to be joined. They are clamped between two boards



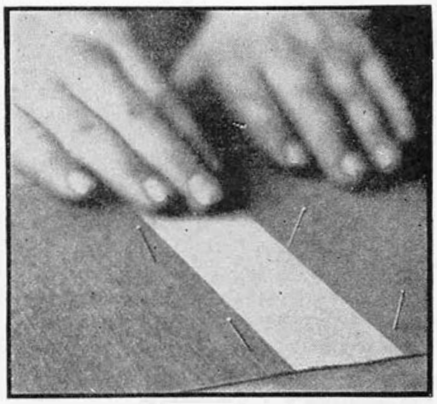
How to veneer a box and four additional suggestions for corner treatments. Cutting off the lid is the last step

The face veneers may be made up in any number of ways. For the beginner, a panel with a border around it is about the simplest. Lay out the panel and border directly on the surface to be veneered. Clamp the panel between two hardwood boards, plane its edges and ends to exact dimensions, and tack it to the box with fine brads. Cut the strips for the border about ⅛ in. wider than needed and join them side to side. Plane one end, lay out and cut the miter joints, and tape the border face veneers to the to the sides and ends of the panel. Glue the ends first, then to the sides, and finally to the top. They should be fastened with at least four brads each to prevent them from sliding.

Lines and insets may be obtained in different widths and patterns. Grooves for them may be cut by hand with a homemade steel cutter, used in a marking gage. Since some of the veneer must be cut across the grain, the outlines of the groove must first be cut with the spur of a marking gage filed to a knife point. The black lines are held in place with strips of gummed paper while the glue sets.

When dry, the inlays are scraped flush with the surrounding surfaces, after which the box is given a thorough sanding. It is then cut open with a fine back saw, guided by two strips clamped on each side of the gaged line. Smooth and stain the edges and apply the hinges and lock.

In most cases the veneered surfaces should not be stained. Apply a thin coat of paraffin oil, obtainable in any drug store. Let the work dry for twenty-four hours, wipe thoroughly, and apply three or four coats of very thin shellac. Let each coat dry about four hours and then sand it with very fine sandpaper.



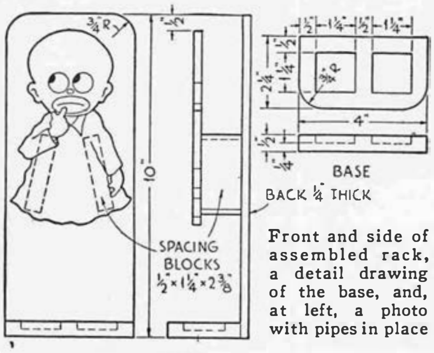
The joining pieces are fastened to a board with small nails, and paper tape is applied

PICKANINNY PIPE RACK IS AMUSING NOVELTY

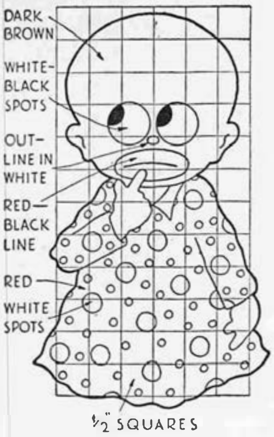
HERE'S a novelty in pipe racks. Two of your favorite briers form the legs and feet of a gayly attired, timid-faced dusky youngster. It will serve equally well as a wall or a table rack.

Only five pieces are necessary. The figure is made from ¼-in. thick wood. Enlarge the pattern for this piece to the required size by means of the squares, transfer the design to the wood, and jig-saw to shape. Make the back also of ¼-in. material, but use ½-in. thick wood for the base. Lay out the pipe recesses and rout or chisel them; then saw the piece to shape. Make two spacing blocks of the size shown. Assemble the rack with glue and brads.

Sandpaper the entire assembly, then give it a coat of flat paint or prepared enamel undercoater, after which the desired colors may be applied. The back and base of the original were finished in pale green, and the figure colored as noted. A picture hanger should be tacked at the top of the back piece if the rack is to hang on the wall; otherwise glue felt under the base.



Front and side of assembled rack, a detail drawing of the base, and, at left, a photo with pipes in place



NOVELTIES ALWAYS IN DEMAND

You'll find your friends appreciate novelties like this pipe rack, and making them is a pleasant relief from more serious home workshop tasks. Besides, the cost is trifling

TABLE LAMP BUILT IN FORM OF TREE

YOU have never seen a lamp as lovely as a tree, but this one comes close to it, with its trunklike support and shade of leafy green. In constructing one like it, the first step is to glue six blocks on a white pine post as shown in the drawings. A hole is bored through the center, and the post is turned to shape.

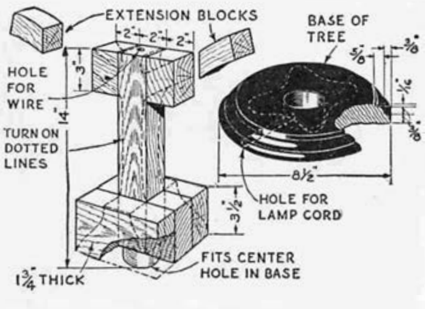
Round up the stub branches at the top with a rasp and file. The ends may be finished to resemble broken ends or hollow limbs. The base of the trunk is then shaped irregularly to resemble the roots. The roughness of the bark is imitated by rasping irregular grooves in the surface, and the whole is given a coat of brown stain, which is all the finish it will need.

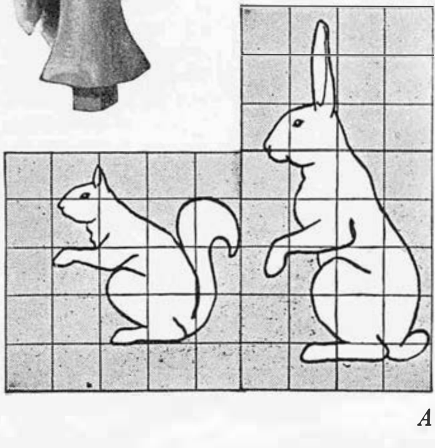
The base of the lamp is turned from walnut and bored as shown with holes to receive the cord and to fit the pin on the lower end of the post. The center part of the base is painted green to represent grass, while the outer edge is given a rubbed varnish finish.

The little squirrel and rabbit, sawed out on a scroll saw, are optional with the builder, but they add a realistic touch. They are fastened on with a pin driven down through the body into the base.

The shade may be made of parchment or oiled poster board. The leaf design is drawn with crayon or colored pencils. It runs through a range of colors from light green on the upper portions to dark blue-green, with black in between. The colors are fixed by spraying on a coat of fixatif. Then the shade is glued up. A wire frame to clip over the bulb holds the shade in place.

A tree lamp with leafy-looking shade and, below, the trunk after being roughly turned to shape, but before the stub branches have been rounded off





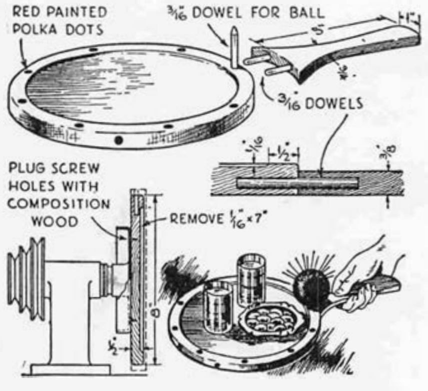
How the trunklike column is made by gluing blocks of wood at the top and bottom of a central piece 2 by 2 by 14 in.; a drawing of the base; and, at right, patterns for a squirrel and rabbit for decorating the base

ONE-HANDED TRAY MADE FOR SERVING SNACKS

A UNIQUE serving tray for between-meal snacks is illustrated below. It is simply a turned wooden disk with a handle and a sponge-rubber ball in which are thrust vari-colored toothpicks for lifting squares of cheese or olives.

Gumwood has a beautiful grain and is well adapted for making this piece. Cut a disk roughly from 9/16-in. surfaced material, about 8¼ in. in diameter, and secure it to a faceplate with short, blunt screws. Turn the outside rim and then cut a depression in the face of the disk 1/16 in. deep and 7 in. in diameter. Smooth with sandpaper or, preferably, fine garnet paper.

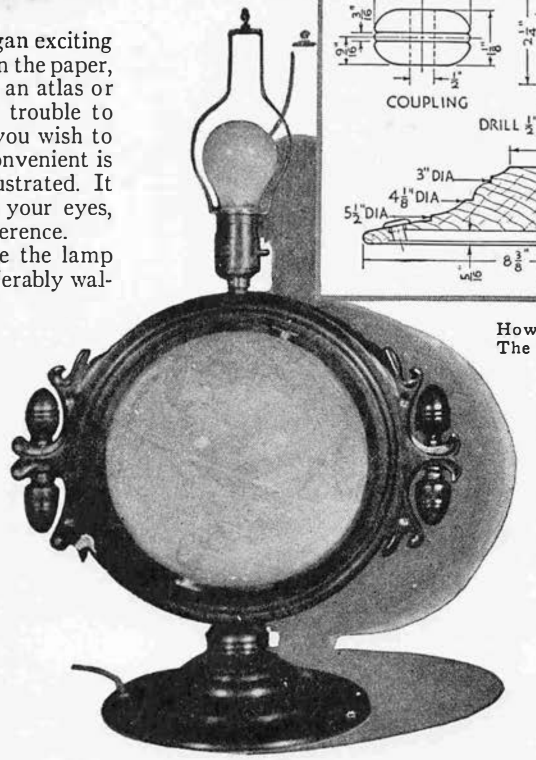
Drill the holes for the dowels while the rough stock is in the square. The dowels and joint should be fastened with glue of the best quality. Drill for the dowel that is to hold the sponge-rubber ball, but do not set it in permanently until the wood has received the final finish. This consists of four coats of shellac with a fine-grade sandpaper treatment after the first, then steel-wool rubbing after the second and third. The ball can also be shellacked and glued to the dowel. Before the last coat of shellac, paint red polka dots on the rim as indicated.

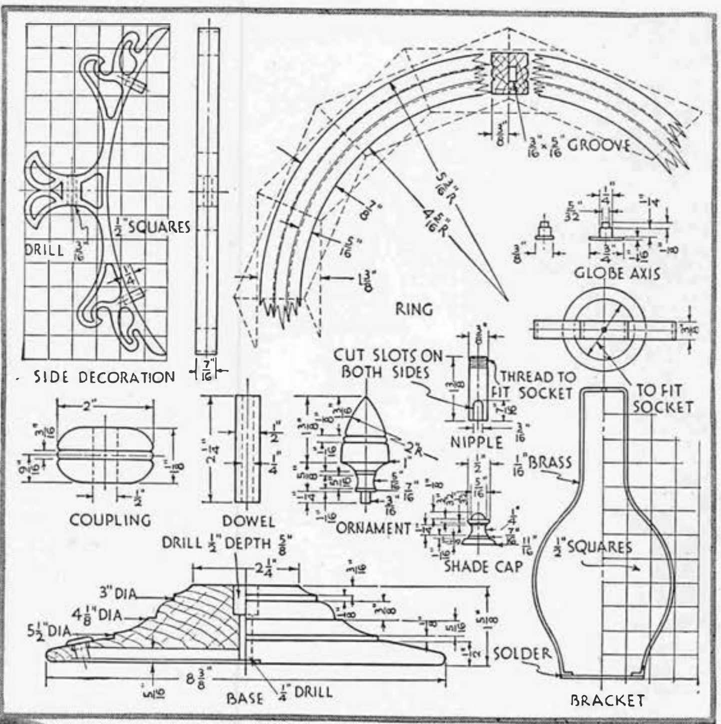


How the tray is constructed and used. The sponge-rubber ball holds colored toothpicks

Geographical Globe

Mounted Under Reading Lamp





How the parts are made and, at left, the assembled lamp. The globe axis is at a 25-deg. angle from the vertical

WHEN you are readingan exciting bit of foreign news in the paper, you often feel like referring to an atlas or geography, but it is too much trouble to get up and hunt for the map you wish to consult. What is much more convenient is a table lamp like the one illustrated. It keeps the whole globe before your eyes, well illuminated for instant reference.

All that is required to make the lamp are a few pieces of wood, preferably walnut, an 8-in. terrestrial globe, which may be purchased at any office supply store, and the necessary electrical fixtures.

In making the ring, which is built from segments, sixteen pieces of wood 7/16 by 1⅜ by 4¾ in. are needed. Screw a piece of wood ¾ in. thick by 11 in. diameter to the lathe faceplate, true this, and glue on a sheet of paper or cardboard. Glue the first layer of segments to this paper. After the glue has hardened, turn the face to ⅜ in. thickness, 10⅜ in. outside diameter, and 8⅝ in. inside diameter. Turn the groove for the lamp cord next. Glue on the next layer of segments as shown, and turn to the dimensions of the first layer. Then turn the bead. Separate the ring from the wooden disk by inserting a chisel into the paper to split it. To turn the bead on the opposite side, chuck the ring by turning a recess in the wooden disk to fit the outside diameter of the ring tightly.

Turn the base and side ornaments. The base is gouged out at the bottom for the lamp cord as shown. A piece of wood 1/16 by ⅝ by 4 in. is then fitted into the base to cover up the cord. The side decorations were carved on the original lamp, but they may be simplified by cutting them out on the jig saw as shown on the drawing, or they may be omitted.

Pull silk lamp cord through the base, and remove the silk covering from the end for a distance of 18 in. Pass one wire up the left side of the groove and the other up the right, both meeting at the top. Slip the nipple into the drilled hole at the top of the ring after cutting slots to fit over the wires.

Now the lamp may be permanently assembled, sandpapered smooth, and stained to desired shade. If open-grained wood has been used, apply paste wood filler, rubbing it off after it has turned dull. Let it stand for twenty-four hours before applying the first coat of varnish. Allow this to dry for three days, and then sand smooth. Apply the second coat, and allow it to dry from four to five days. This should then be rubbed with fine pumice stone and rubbing oil, followed with rottenstone and finally with a good grade of furniture polish.

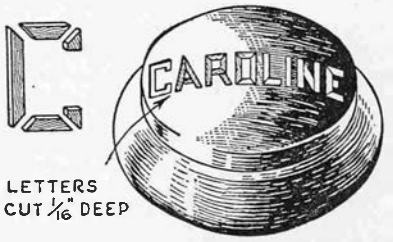
To support the globe, make two axes from 1/16 by ⅜ by ¾ in. brass, to which is soldered a ¼-in. brass rod filed to the diameter of the hole in the globe.

The lamp shade may be purchased or made from parchment paper cut to the required shape and reenforced at top and bottom with wire and binding. Silhouettes may be painted on.

HOW TO INLAY NAMES IN WOODEN NOVELTIES

Small turned wooden box with name inlaid in the cover to make it a more personal gift

To INLAY names or designs in small boxes like the one shown, lay out the letters with a sharp pencil, and cut the outline about 1/16-in. deep with a jack knife. Inlay with any contrasting wood, mitering the joints wherever possible. When the glue has dried, sandpaper and finish.

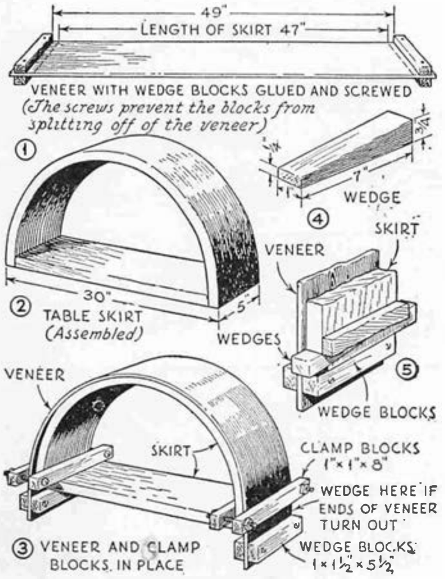


Square-cornered letters are used so that the inlaid strips may be cut with mitered joints

HOW TO VENEER SKIRTS OF HALF-ROUND TABLES

THE seemingly difficult task of veneering a curved surface is easy when one knows how. Cut the veneer ½ in. wider and 6 in. longer than necessary. Assuming the dimensions in Figs. 1 and 2, prepare four blocks 1 by 1½ by 5½ in. and fasten them to the veneer in pairs with glue and two 1¾-in. wood screws as shown in Fig. 1. Make two clamps as in Fig. 3, and bore them in pairs for 4 by ¼-in. bolts, 6½ in. apart. Also make four wedges, Fig. 4.

Use cold water or prepared liquid glue, as hot glue chills before the joint can be made. Apply glue to 3 in. at one end of veneer and skirt and place veneer on skirt. Fasten one set of clamps as in Fig. 3 with only enough pressure to keep them in position. Apply glue on the remainder of veneer and skirt. Bend veneer around skirt and fasten the other set of clamps. Between the ends of the circular skirt and the blocks on the veneer, insert wedges as in Fig. 5. Press veneer with hands, working from center to ends, as in massaging. If the ends of veneer turn outward, place a pair of wedges as indicated in Fig. 3. Drive these wedges only hard enough to keep the work in position.


49"
LENGTH OF SKIRT 47"
VENEER WITH WEDGE BLOCKS GLUED AND SCREWED
(The screws prevent the blocks from splitting off of the veneer)
①
7"
WEDGE
④
SKIRT
VENEER
②
30"
5"
TABLE SKIRT (Assembled)
WEDGES
⑤
WEDGE BLOCKS
VENEER
SKIRT
CLAMP BLOCKS 1"×1"×8"
WEDGE HERE IF ENDS OF VENEER TURN OUT
③ VENEER AND CLAMP BLOCKS IN PLACE
WEDGE BLOCKS 1×1½"×5½"

The veneer is clamped tightly against the curved surface by driving wedges where shown

When the glue is thoroughly dry, remove wedges and clamps, and trim veneer to size of skirt. Always veneer round table skirts before attaching the legs. To veneer a skirt in this way with the grain of the veneer vertical, or across the skirt, first glue the face veneer across the long piece, as in cross-band veneer, and proceed as before.

If it is desired to use a crotch, burl, or other fancy veneer in which there may be bulges, substitute for the veneer in Fig. 1 a piece of tin or galvanized sheet iron not heavier than 26 gauge. Attach the wedge blocks with three screws, but otherwise the same as Fig. 1. Join up with paper tape all the pieces of veneer until about 1 in. larger than skirt. Apply glue to surface of skirt and place veneer on skirt. Drive two or three ½-in. No. 20 brads at center to hold veneer. Apply band clamps and wedges as previously described.

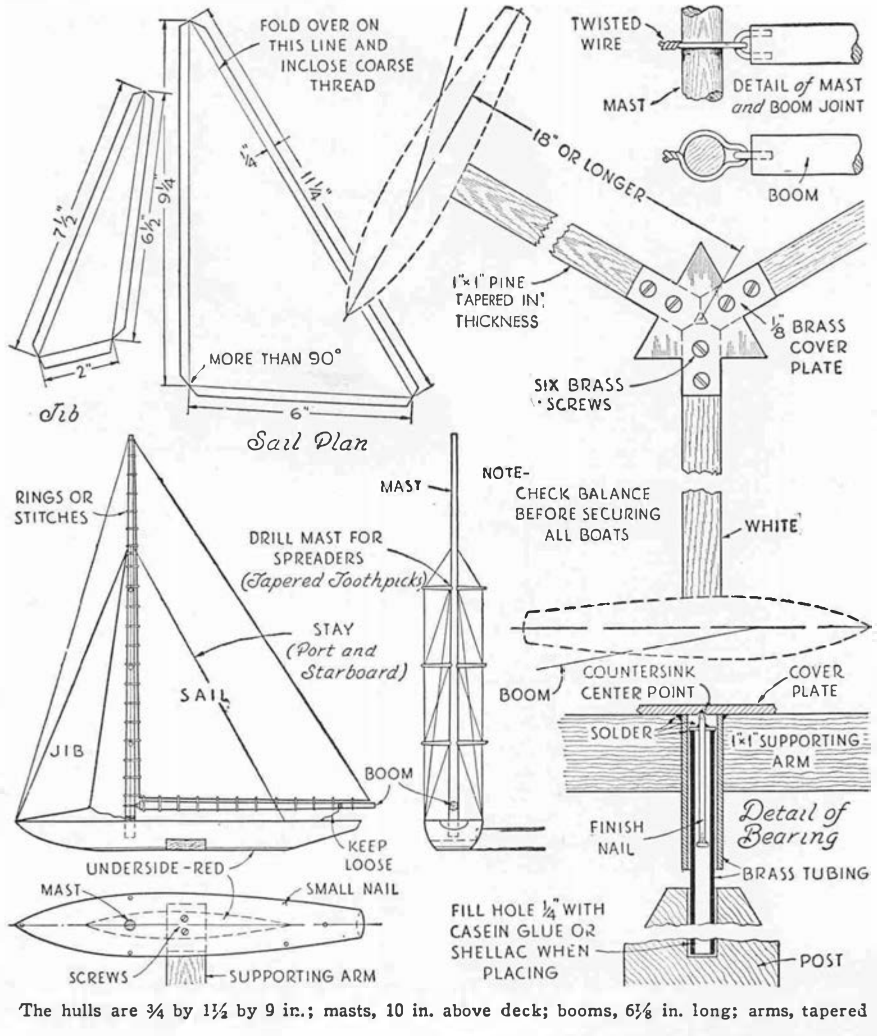
Yacht-Race WINDMILL

...A Cape Cod Novelty in Which Three Little Boats Go Round and Round

A NOVEL Cape Cod windmill in which three miniature yachts appear to be sailing an endless race can be easily constructed as shown. Although any design or number of sailboats may be used, the type illustrated gives the most even rotation, and an odd number of vessels looks better.

The sails should be made to the size shown before they are attached to the masts and booms.

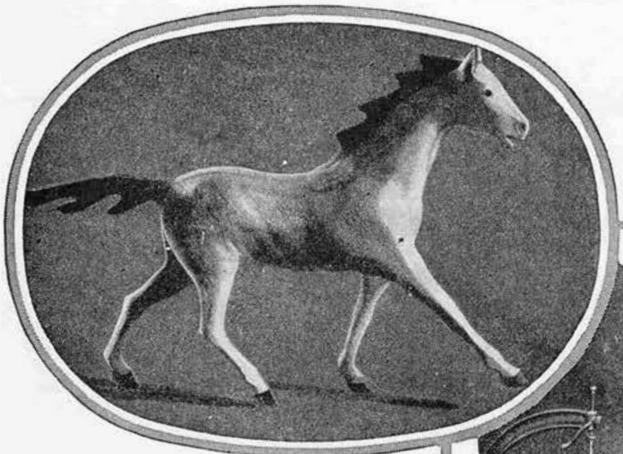
A simpler type of bearing may be used, but the balance must be correct to insure perfect rotation. Countersink the bearing first and use the countersunk spot as a center point for laying out the brass cover plate. When the necessary lines are scribed, solder 3 in. of tubing to the plate. There must be twice as much tubing in the post as exposed. Graphite is used for lubrication.

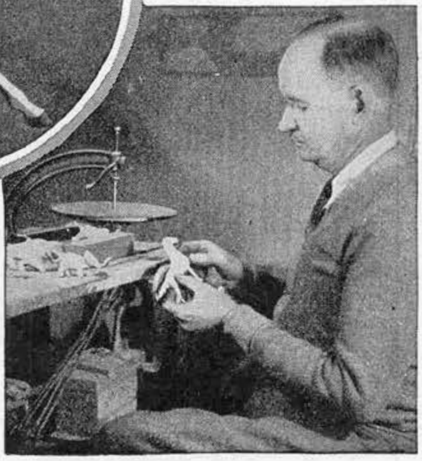


The hulls are ¾ by 1½ by 9 in.; masts, 10 in. above deck; booms, 6⅛ in. long; arms, tapered

Carving *with* Jig-Saw *and* Sander

A Novel Way to Sculpture Animals, Birds, Figures, and Other Ornaments





These photographs show the surprising realism of the animals jig-sawed in sections, then finished with a disc sander

JIG-SAW sculpture is the art of making what look like hand-carved animals, birds, and other ornaments with nothing more than a motor-driven jig saw and a disk sander.

Two examples are given—a horse and a squirrel. These have been drawn looking straight ahead for simplicity of construction. As one becomes more expert, it is possible to build them up with the head turned, or with a leg stretched out to the side.

The horse is a pacer and requires only three jig-sawed parts. For a model, of the size shown, ¼ in. thick plywood will be satisfactory. White wood (poplar), birch, or basswood give excellent results. The legs will be much stronger if two-ply instead of three-ply is used for the outer sections. Two-ply can be easily made in small pieces with casein glue if a letter-press or other press is available. The center section can be made of three-ply fir or any other inexpensive wood. Fir is mentioned as most plywood manufacturers carry it made up with waterproof glue. If this is not used, dip the finished model in flat varnish, which will help in keeping out dampness.

Make your sketch, divide it into three parts as illustrated, and trace the sections on the wood. For cutting, a No. 3 blade will give good results.

The "carving" is done with fairly coarse sandpaper on a motor-driven circular sander, revolving in a vertical plane. The inside of the horse's legs and ears should be shaped on the sander before any gluing is done.

It is a good idea to drive fine wire nails into the shoulders and thighs of the horse after gluing in order to prevent the sections from slipping out of place when put in the press for two hours or more to dry. If the nails are driven in part way and the heads are clipped off before sinking them, they will not be seen.

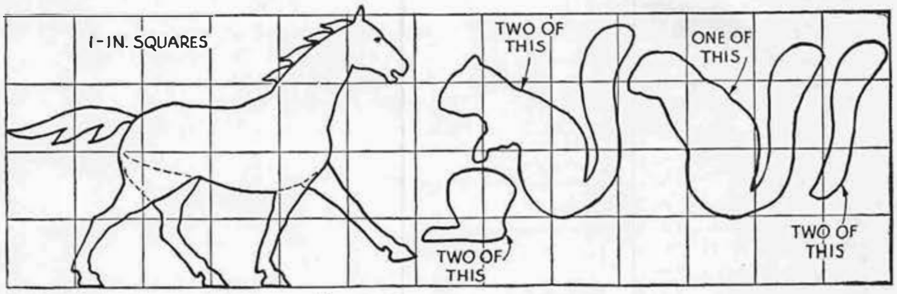
After the glue has set, the horse can be sanded down and shaped. Holes for the eyes are cut with a small gouge, and a still smaller hole is made at their centers. The holes are filled with cellulose household cement, and glass-headed pins are sunk into them after all but ⅛ in. of the steel wire has been clipped off. Staining adds the finishing touch.

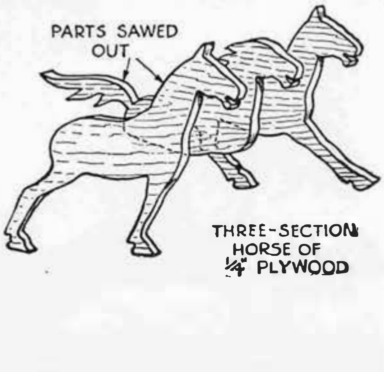
The squirrel is made in the same manner from 3/16-in. plywood except that there are five sections.

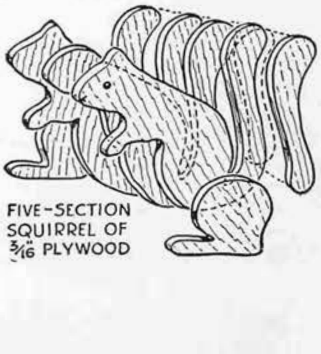
This means may be used to decorate book ends, where half of an animal or small sailboats may be applied, trays with carved handles, and small tables with central ornaments of animals, birds, or boats.

Profit in Selling Jig-Sawed Novelties

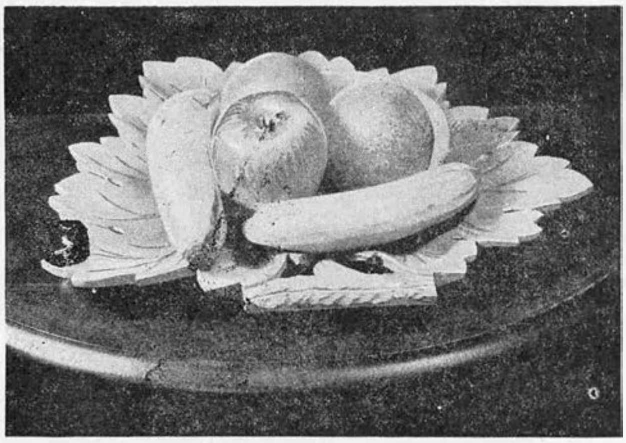
THE HOME WORKSHOP can be a steady source of extra income to the man who makes novelties of this kind. A jig-saw and sander are the two power tools used for the figures shown on this page, and the manner in which they are built up gives them a finished look that makes them sell readily.



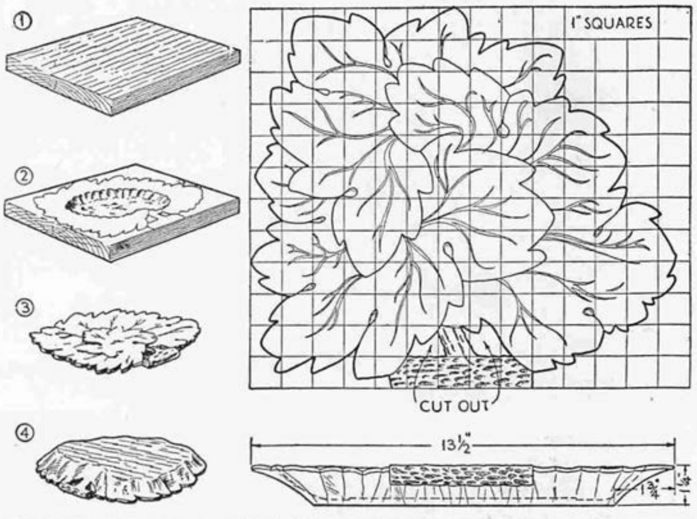




WOODEN FRUIT DISH CARVED TO REPRESENT LEAVES



The dish is carved from a close-grained, light-colored hardwood



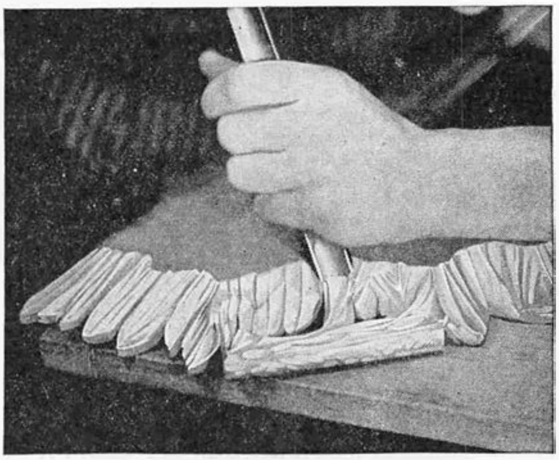
How to lay out the pattern of three interlaced leaves; an edge view showing depth to which dish is hollowed; and four steps in making the project

REMINISCENT of the art of the ancient wood-carving guildsmen, this fruit dish imparts an air of richness to the dining-room table or buffet. The design is a triad of large leaves carved from one piece of wood.

The dish may be made entirely by hand with carving chisels, or a flexible shaft with routing cutters and other home workshop machines may be used for much of the work, if available. The stock may be birch or any other close-grained wood that can be had in a size 12 by 13½ by 1¼ in.

Lay off the top in 1-in. squares and copy the outline of the dish from the accompanying drawing with the grain running the long way. Use a machine wood bit having a very short spur, if possible, to rough out the deepest part of the dish. Follow closely the course of the dotted line shown in the edge view. Remember to allow for the depth of the bit spur and when in doubt bore shallow holes in preference to going the limit.

With a gouge rough out the remainder of the interior. Allow ½ in. for the thickness of the leaves where they overlap in the center. The average thickness of the dish other than this area is 5/16 in. Direct-reading or lock-joint transfer calipers are a great help in testing the thickness of the wood. It is better to be cautious rather than risk spoiling the stock by cutting in too far.



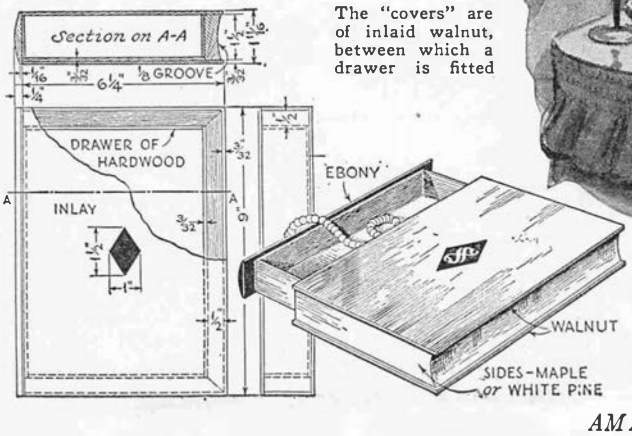
Now comes the sawing. Follow the general outline with the jig saw and then saw out the detail of the leaf lobes. Drill holes for the saw and remove the pieces marked "cut out." Turn the dish bottom up and use a gouge to slope the edges to the form indicated in the drawing. A veining tool gives the bark appearance to the twig. With light, smooth cuts bring the inside of the dish to the design shown, leaving the edges of the twining leaf lobes standing 3/16 in. higher than the adjacent area toward the outside. Make the veins in graceful swings, about 1/16 in. deep, using what is commonly known as the reverse or ogee curve.

Start removing the gouge marks with a medium grit sandpaper and finish with a finer grade. Leave uniform gouge marks on the sloping sides of the underpart. Paste furniture wax is rubbed into surface.

GIFT JEWEL BOX OF WOOD LOOKS LIKE BEAUTIFULLY BOUND BOOK

DESIGNED to resemble a book, the jewel box illustrated is an unusually attractive project for a Christmas gift. It requires very little stock and there is nothing difficult about the construction.

The box or cover is made of three sidepieces of maple or white pine with mitered joints, and a top and bottom of 3/32-in. walnut. The long sidepiece is grooved about ⅛ in. deep as indicated. This can be done by hand with a gouge, or the groove may be cored out with a circular saw. The top and bottom pieces may be inlaid with a small lozenge of holly or other light wood as shown, or with a more elaborate inlay, if preferred. The other part is merely a drawer of hardwood made in the form of a box to slide into the cover. To the front of the drawer is glued a piece of ebony or other dark wood shaped like the slightly rounded back of a book.

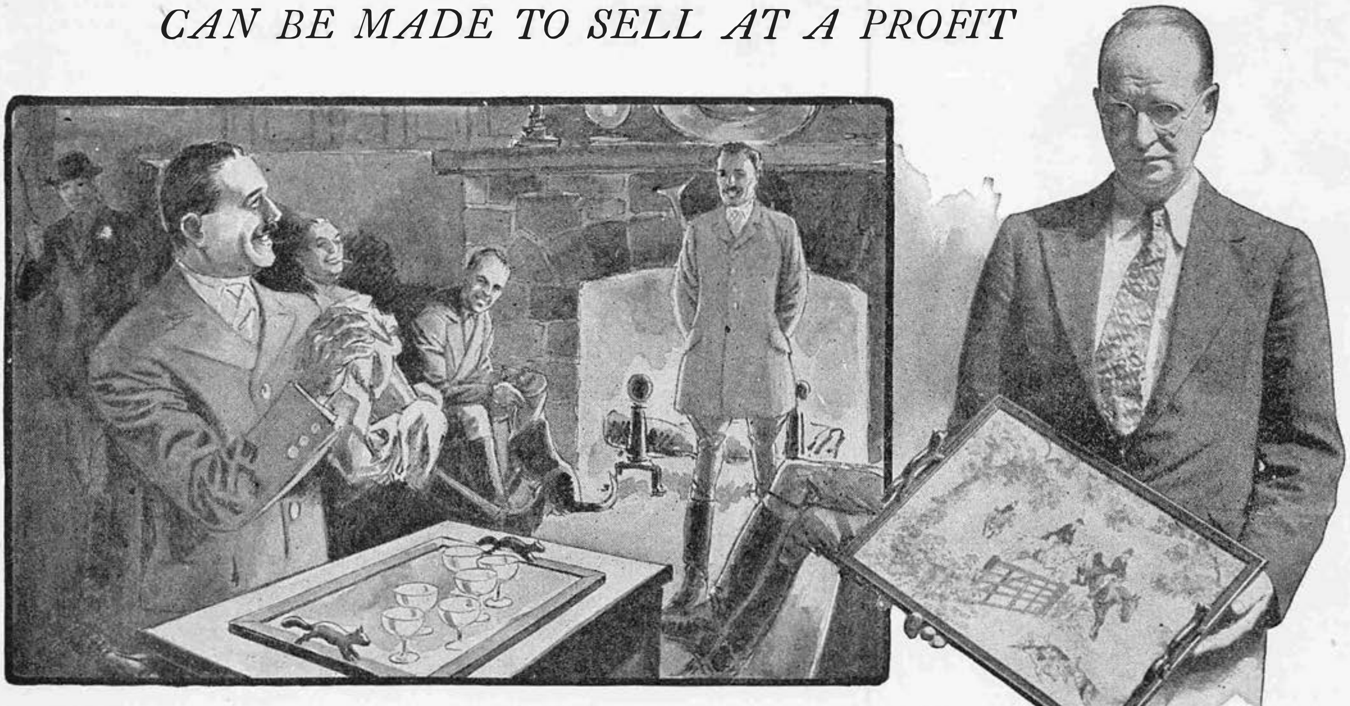


The "covers" are of inlaid walnut, between which a drawer is fitted

Apply a light wood filler to the walnut; then give the entire box a rubbed varnish finish.

Trays *with* Animal Handles

CAN BE MADE TO SELL AT A PROFIT



Decorative handles, which look to be hand-carved from wood, are the feature of these trays. The pictures are cut from wall paper and glued on strong composition board

UNUSUALLY attractive trays that will serve as gifts or may often be sold at a good profit, because they look to be difficult and expensive to make, can be constructed by a very simple method. Their main feature is the ornamental handles—small animals cut out on a jig saw and "carved" on a sanding disk. These handles are so unique and seem to require so much more time and skill than they really do, that they invariably attract attention.

A convenient size for the trays is 13 by 20 in. Pressed wood composition boards 3/16 in. thick are recommended, as this material has no grain to cause warping. One side of the board is rough, with cloth pressed into its surface. Two coats of wall-paper size should be applied to this surface before coating it with white water-resisting casein glue. Wall paper is then used to cover this rough side of the board. Many beautiful designs are available, such as the fox-hunting scene illustrated.

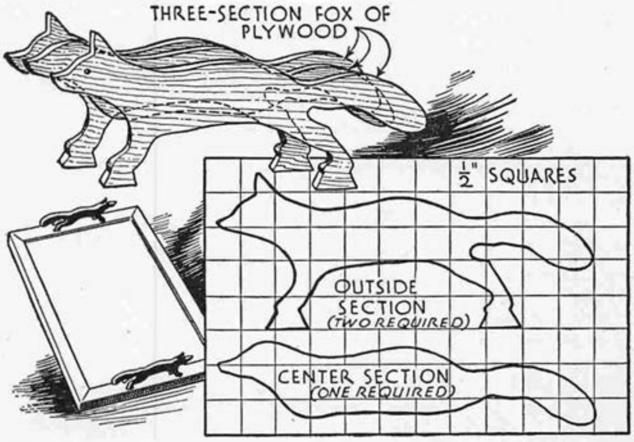
The back of the paper is given a coat of size to prevent the glue coming through and causing stains. The glue itself is allowed to stand for half an hour after the powder has been mixed with cold water. A few minutes before you are ready to apply the glue with a stiff brush, give the wall paper, which should be cut so that it will overlap the board a little on all sides, a second coat of size. Spread the glue on the rough side of the board, and apply the paper while it is still wet. Smooth out all wrinkles. A rubber roller will be found useful at this point. Place a piece of smooth board over the paper, and pile heavy books or bricks on top of it. Allow several hours for drying. The wet wall paper shrinks, and a much smoother surface is obtained than if the paper had been applied dry.

The next step is to apply two coats of size to the face of the paper, allowing an hour or more for each coat to dry. Then a coat of spar varnish is applied to one side of the unframed tray; and after it has dried, the opposite side is treated in the same way. If the paper has curved the board, bend it back into shape before applying the edges.

A small circular saw speeds up the operation of cutting the boards, and if it is equipped with a mitering guide, it can be used for cutting ½ by ¾ in. strips of wood known as "check stop" to form the raised edges for framing the tray. A dado cutter for making a 3/16-in. groove is set for a cut ¼ in. deep and is used on one of the narrow faces of the check stop before it is cut to the required lengths. If a dado is not available, your lumber company can probably supply the material properly grooved.

The border of the tray shown is painted a tulip red to match the hunting coats. The edges of the check stop along the groove should be painted and allowed to dry before fitting the mitered pieces in place around the pressed wood board; this does away with the chance of getting paint on the surface of the paper. The pressed wood should be very slightly beveled on the back edges. Care must be taken to see that the wall paper fits smoothly in the groove. All mitered corners are glued with waterproof casein glue and held in place with small wire nails. After the glue has dried, the nails are countersunk, and the holes filled with crack filler.

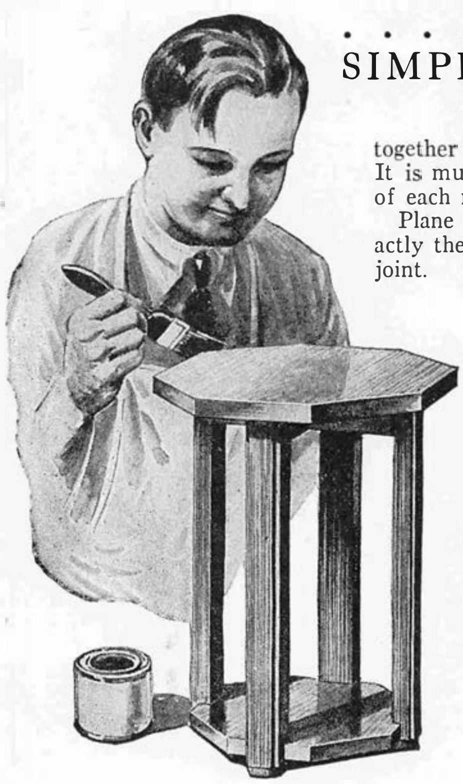
The handles are made as described on a preceding page, except that the feet are dovetailed to fit recesses in the tray. Stain the foxes light mahogany, except the underpart of the neck and belly and the tip of the tail, and glue in place. The animals' legs and ears are stained black, and black glass-headed pins form the eyes. Give the completed tray, handles and all, two or more coats of good spar varnish.


THREE-SECTION FOX OF PLYWOOD
½" SQUARES
OUTSIDE SECTION (TWO REQUIRED)
CENTER SECTION (ONE REQUIRED)

Each fox consists of three jig-sawed pieces, which are glued together and sanded to shape. The dovetails are set into the frame

Smoking Stand

. . . . DESIGNED ON SIMPLE, MODERN LINES



A SMOKING stand of modern design such as the one illustrated is a useful little piece of furniture, and it can easily be made from odds and ends around the shop. By varying the height and width or by adding a shelf, the stand may be used for other purposes—for example, an end table, a coffee table, or a stand for a large ornamental vase, flowerpot, or statuette.

The construction is quite simple. First, plane the stock for the legs and the top crosspieces, which have a cross-lap joint, because these parts are of the same width and thickness. It is more convenient to make the cross-lap joint from one piece 20 in. long instead of from two pieces 10 in. long, since it is easier to plane one piece to dimensions than two.

When laying out the joint as shown in the detail drawing, be careful to get it in the center so that the four arms of the joint will be of the same length. If the joint should be too tight, do not try to force it together and do not try to make the cuts wider. It is much easier to plane a little off the sides of each member to reduce their thickness.

Plane the bottom, which is eight-sided, to exactly the same width and length as the cross-lap joint.

The joints in the legs where they fit over the bottom and the cross-lap joint are now laid out and cut as shown on the detail drawings. Place the legs edge to edge and square lines across them all at the same time. In this way the bottom and the cross-lap joint will be exactly the same distance apart on all four of the legs.

The grooves and rabbets should be cut ¼ in. deep. It is best to saw part way down inside the lines for the grooves, as the wood splits easily lengthwise when a chisel is driven in with a mallet. Saw the rabbets across the grain and chisel from the end. Finish all grooves and rabbets with a router plane, if available. It is very important that they are all cut to the same depth.

An alternate design in which top, bottom, and feet are circular

The stand may be doweled or screwed together. If dowels are used, they should be ¼ in. in diameter and at least 1½ in. long. Lay out the position of the dowels on all the legs. Clamp the joint, the bottom, and two opposite legs together while boring for the dowels. If the dowels are cut ⅛ in. shorter than the depth of the holes, the clamps can be placed over them and the stand clamped tightly together when gluing. Put glue in the grooves and rabbets and on the ends and edges of the cross-lap joint and bottom. Dip the dowels in glue and drive them home.

Before gluing, four 7/32-in. holes should be bored through the arms of the cross-lap joint, 1½ in. from the ends. They should be countersunk on the underside so that the top can later be fastened to it with screws.

The ⅛ by 1¼ in. strips of wood, which cover the dowels or the screws as the case may be, can be planed and smoothed with scraper and sandpaper in a jig as shown on the drawing. They are located on the legs with two small brads, which can later be withdrawn. Clamp a piece of wood over the strips while gluing.

The top should be made from two or three boards glued together rather than from one wide board, which is more likely to warp. Joint (plane) the edges of the boards by clamping them side to side and planing two at a time. Be sure that the joint fits.

After the top is placed and smoothed to size and shape, it is placed face down on the bench with the lower part of the stand on top of it. Be sure that the grain of the top runs in the same direction as that of the bottom. Center the top by measuring from its edge to the face of the leg. Fasten with 2-in. No. 12 flathead screws.

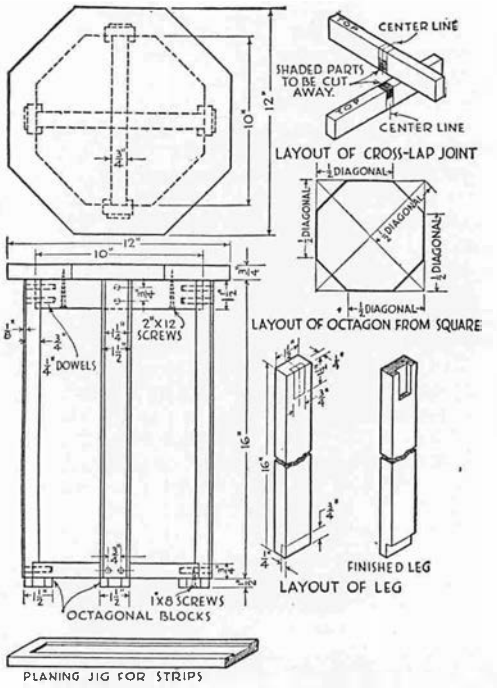
The feet for the stand may be sawed from a piece of wood planed to an octagonal shape lengthwise.

After a thorough cleaning up and sanding, the stand is ready for finishing. It may be stained in two tones or painted in two colors. Clear and colored lacquers may also be used. In any case it will be most effective if the strips and edges of top, bottom, and feet are stained or painted a darker color than the rest of the stand.

If the stand is stained, it may be finished with three or four coats of very thin shellac. The shellac should be thinned with alcohol until it is as thin as water. Let each coat dry at least two hours and rub down with No. 2/0 or 3/0 steel wool. Finish the last coat by rubbing it with crude oil and No. 5/0 waterproof sandpaper or powdered pumice stone.

List of Materials

No. of Pieces	Description	T.	W.	L.
4	Legs	¾	1½	16
4	Strips for legs	⅛	1¼	16
1	Cross-lap joint	¾	1½	20
1	Bottom	¾	10	10
1	Top	¾	12	12
4	Feet	½	1½	1½
16	Dowels	¼	round	1½
4	Screws	2-in. No. 12		
4	Screws	1-in. No. 8		



Assembly drawings, details of the cross-lap joint, legs, and planing jig, and how to lay out an octagon

Antique Jigsawed Bookshelf

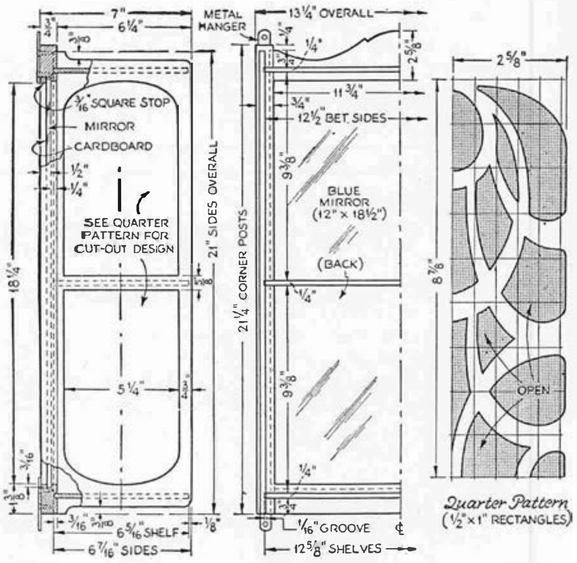
HAS BLUE MIRROR BACK

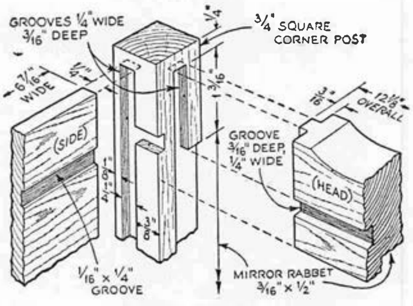
A DISTINCTIVE setting for a favorite bit of bric-a-brac is the eighteenth century hanging bookshelf illustrated. It is made doubly charming by its mirror back. If, in addition, the mirror is of dark blue plate glass, a particularly rich effect is obtained. Your glass supply house can usually obtain this with little trouble at a reasonable price. The blue mirror used in the model illustrated cost $2 compared with $1.35 quoted for a clear glass mirror.

The design consists essentially of a mirror frame grooved to take the ¼-in. wood of which the sides and shelves are made. Glue joints are used throughout. If you do not care to put too much dependence upon your glue joints, ¾-in. brads may be used to reenforce them.

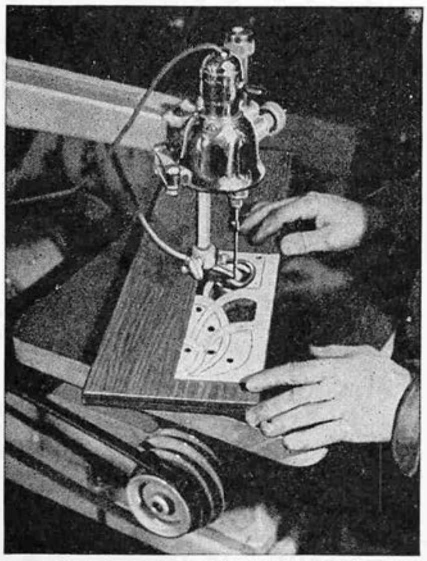
It is suggested that the mirror frame, consisting of the corner posts and head- and tailpieces, be machined and glued up as the first step. A study of the corner-joint assembly sketch will aid in clarifying the grooving of these members, which may be done on the saw or vertical spindle shaper or with a routing cutter on the drill press.

After the frame is dressed and sanded, the sides and shelves may be fitted to it and to each other. The sides should be squared to the over-all size of 6 7/16 by 21 in., but leave the trimming of their ends to contour till after the scrollwork is done. They are grooved 1/16 in. deep to take the shelves. The location of these grooves should be carefully checked with the spacing of the grooves in the head- and tailpieces, which take the rear edge of the shelves.





How parts are grooved. A saw, vertical spindle shaper, or routing cutter may be used

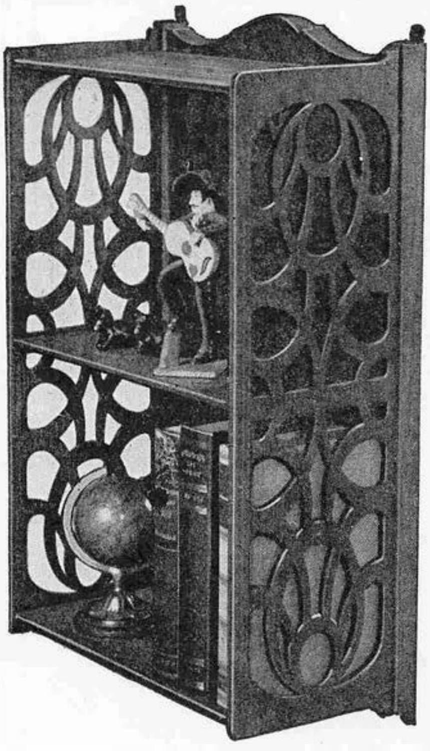


The two panels are tacked together, a quarter of the design sawed, and then one panel is used to mark the full design on the other

Now draw a quarter pattern only of the scrollwork on thin paper. Apply this in the proper location on the wood with rubber cement. In using this cement, apply a coating to both wood and pattern and allow the coating to dry thoroughly. Then place the paper carefully in position and rub out any entrapped air. The two sides should be tacked together with ½-in. brads through the waste strip at the ends, and the quarter of the design cut in both pieces at once, as shown in one of the illustrations. Temporarily separate the sides and after smoothing up the sawed outline, use the second piece as a pattern to complete the design.

Do all possible scraping and sanding before gluing the sides and shelves to the back frame.

As the application of the standard stain, filler, and varnish is very tedious work on scroll-sawed work and in interior corners, the use of a different type of finish is suggested. This consists of a commercially obtainable stain and wax carried in a penetrating oil, which give a finish closely approaching the results obtained by old-time methods. This is flowed on copiously with a soft brush and rubbed in with a rag after a half-hour interval. Two or three applications may be used at intervals of at least a day.



Hanging shelves for books and bric-a-brac. The back is a dark blue plate-glass mirror. Complete working drawings are given at left

The hangers are simply metal straps with two countersunk holes for ½-in. No. 4 screws (for attaching to the ends of the corner posts) and 3/16-in. holes in the extended portion for long, thin screws into the wall. The projecting portions may be finished with dead black enamel.

The mirror should lie flat in its rabbet so that no strain will be placed on it when the retaining stops are bradded in place. A layer of thin cardboard over the mirror back will give a cushioning effect.

List of Materials

No. of Pieces	Description	T.	W.	L.
2	Sides	¼	6-7/16	21
3	Shelves	¼	6-5/16	12⅝
2	Corner posts	¾	¾	21¼
1	Headpiece (over tenons)	¾	2⅝	12⅛
1	Tailpiece (over tenons)	¾	1⅜	12⅛
1	Mirror, plate glass	¼	12	18½
2	Mirror stops	3/16	3/16	18
1	Mirror stop	3/16	3/16	12
1	Cardboard backing		12	18½
4	Metal hangers	1/16	⅝	2½

NOTE: All wood to be mahogany or walnut. The dimensions are given in inches and represent finished over-all sizes.

SCREW DRIVER HOLDS BOLTHEAD WHILE NUT IS TIGHTENED

IT IS frequently necessary to tighten a machine bolt in a corner where there is insufficient room to use a wrench. If a small slot is filed or cut in the head with a hack saw, a screw driver can be used to hold the head while the nut is being tightened.

ELECTRIC BANJO CLOCK BUILT AT LOW COST

WITH a few tools and ordinary skill, anyone can make a beautiful electric banjo clock. A suitable movement may be purchased or, what is almost as cheap, removed from a small, inexpensive bedroom electric clock.

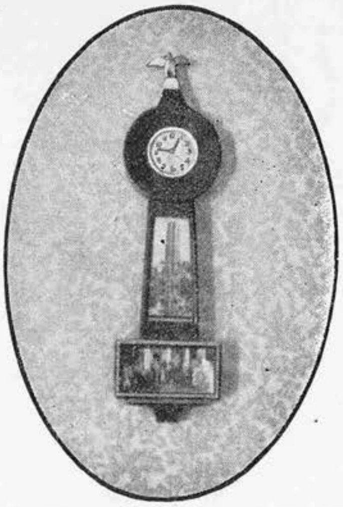
The dimensions of the wooden parts, as given on the drawings, are those used on the original, but you may make your clock larger or smaller. A slightly larger dial would be desirable, if one could be obtained.

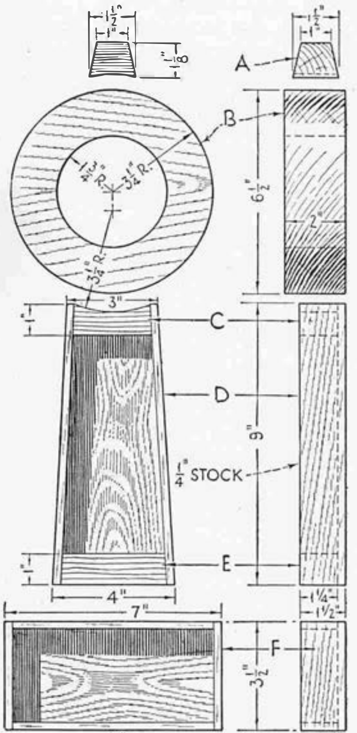
After the various units have been made as shown, fasten *C* to *D* with small brads; then fasten *C* and *D* to *B* by means of a screw and a couple of brads. Have the back of the box and the clock container absolutely flush. Fit *E* inside the lower end of *D* and fasten it with fine brads. Through this sink two screws through the top of *F*. Also carve the lower ornament *G* and fasten it to *F* from the inside. At this stage both *D* and *F* are open in front. Inside these two boxes, glue some narrow strips at the sides, top, and bottom, about 3/16 in. from the edge. Find some suitable colored pictures to fit these open spaces. Back the pictures with cardboard, cut them to shape, and lay them on top of the strips. Cut glass to make a covering for the pictures, making the glass just small enough to fit inside the box and over the pictures. Glue narrow strips of molding around the edges for a frame, mitering the corners carefully.

Now attach *A* and fasten a small gold eagle to it. One can be ordered at any jewelry store, but it is easy to carve this part from wood and attach the outspread wings firmly with pins.

Use a plastic wood composition to fill in all the crevices, and sandpaper the case well. Apply a coat of walnut varnish stain, sandpaper it, and repeat three or four times, or use any other type of finish you prefer. Give the eagle a coat of bronze or gilt. Now fit the movement and bring the electric cord out through the back of the clock.

Screw an eyelet into the back in order to suspend the clock, and also place two rubber knobs at the back in each lower corner so that the cord can pass down in back. If it is desired to place a scroll on each side of *D*, they can be easily cut from thin brass. After being polished, these metal parts should be given a coat of transparent lacquer, which will preserve the luster.

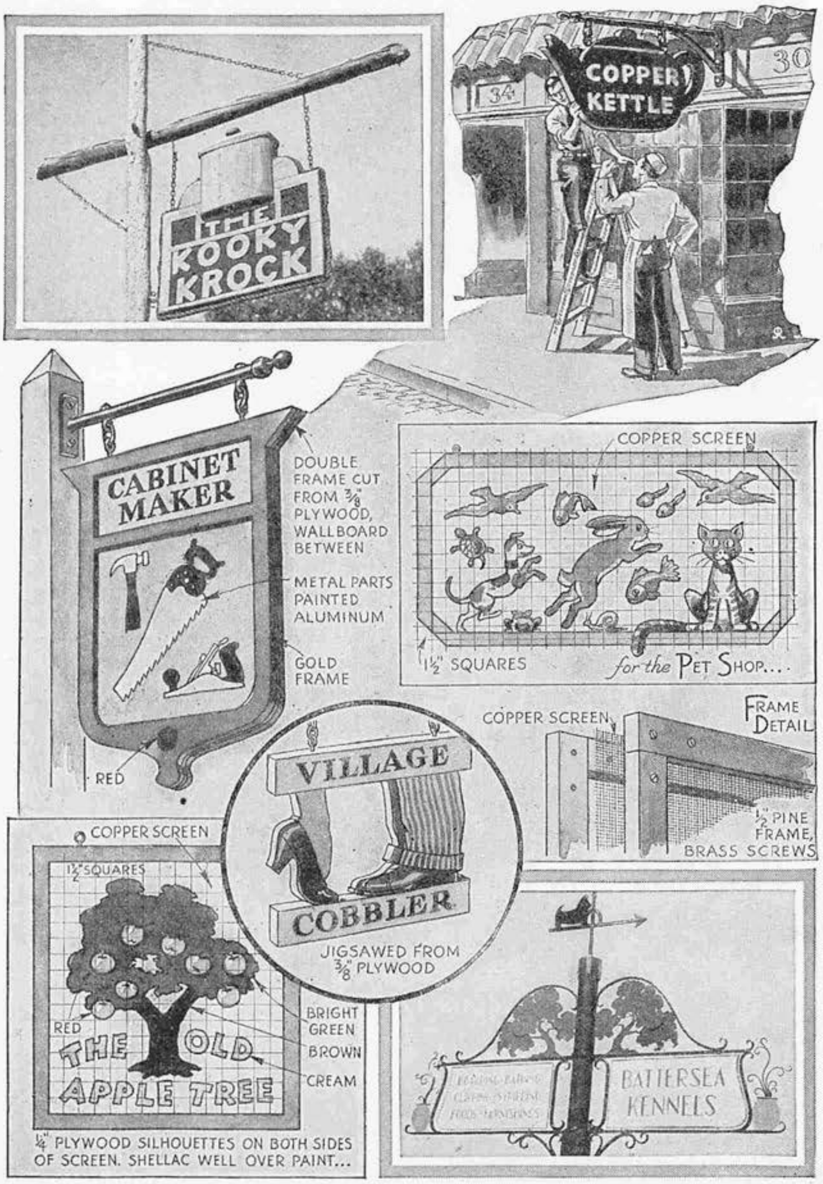




How the individual wooden units are made. Glass-covered pictures conceal the front of the parts marked *D* and *F*

Swinging Shop Signs

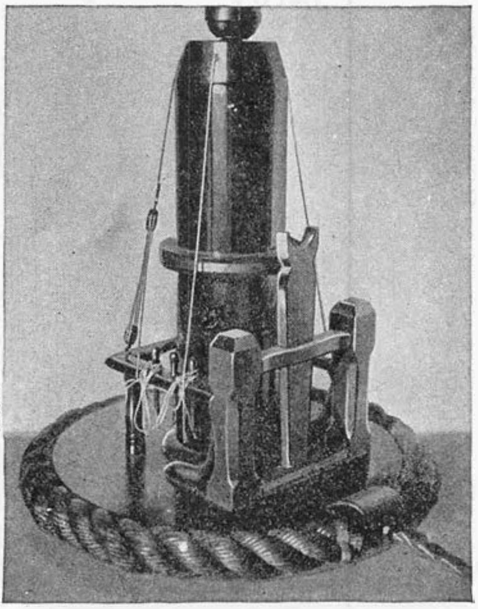
THAT CATCH THE EYE



Unique Nautical Table Lamp

REPRESENTS A SCHOONER'S MAINMAST

The standard of this lamp is a carefully detailed scale model of the lower part of the mainmast of the same schooner painted on the rope-edged shade



The model is complete with bitts, stanchions, fife rail, belaying pins, and even the foreboom crotch

HERE is a table lamp that will appeal to any one interested in ships and the sea. To ship model makers, it offers an opportunity to construct something quite different from the usual line of models.

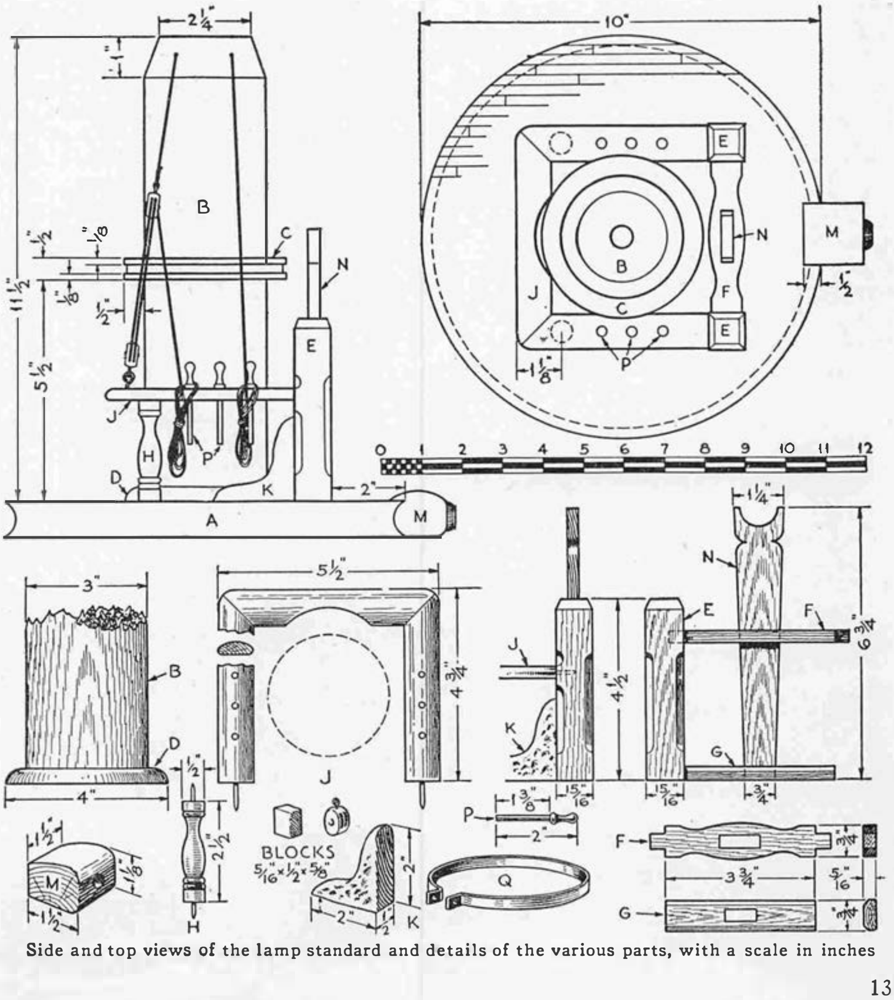
The standard represents the mainmast of a schooner, with the various fittings and a portion of the deck worked out to a suitable scale. A painting of the same schooner was used to decorate the shade, as shown in the photograph of the completed lamp.

The base *A* is a piece of ⅞-in. pine, turned on the faceplate of the lathe to 10 in. in diameter, with a circular groove around the rim ¼ in. deep. The topside, or deck, is ruled with lines ¼ in. apart to represent planking. This is best done with a glass cutter of the wheel type, and a pencil is afterwards run in the grooves to blacken them. The mast *B*, saddle *C*, and housing *D*, are all turned in one piece from birch or other hardwood. Note that the saddle has a ¼-in. groove around the rim, just deep enough to take the strap *Q*, which is made of brass and held in place with a bolt and nut through the outturned ends. All metal parts may be given a coat of aluminum paint to represent galvanized iron, but brass, of course, looks much better on a model of this kind.

A ½-in. hole passes vertically through the center of the mast and through the base. Bore from each end to prevent the hole from running off center. The plug *M* is cut from pine and is set into the base ½ in. A hole passes through this plug and through the base to meet the hole in the center. A 3- or 4-in. piece of brass tubing is threaded into a standard pull-chain socket and secured in the top of the mast. The lamp cord runs down through the mast and horizontally out through the base and plug *M*. The hard rubber bushing which comes with the socket is removed and placed in plug *M* as a finishing touch.

The bitts *E*, stanchions *H*, knees *K*, crotch for foreboom *N*, and the pieces *F* and *G* are all made of pine to the dimensions given in the drawing. The knees are cut out with a pocketknife to represent hand-hewn work. Make the fife rail *J* of black walnut, or a dark piece of mahogany. Glue and dowels—the latter made by cutting the heads off 8-penny nails—securely fasten the fife rail to the bitts, and the stanchions to the fife rail and deck. The knees are simply glued in place, while a countersunk screw through the base holds the bitts. The mast should be held to the base by two 3-in. screws in the same manner.

The six belaying pins *P* are



Side and top views of the lamp standard and details of the various parts, with a scale in inches easily turned from brass welding rod, or, as mentioned before, may be made from any metal if coated with aluminum paint.

Next, obtain a short length of rope having a diameter of 1¼ in. (circumference about 3¾ in.). Wrap it tightly with strong twine about ½ in. from one end, and trim off square with a razor blade, leaving just enough rope to prevent the twine from slipping off. Nail this end in the groove in the base so that it fits closely against the plug *M*. Now cut the rope the required length to fit around the base, and treat the other end with wrapping in the same manner. By twisting right or left as required, the length of the rope may be altered until a snug fit is obtained. Nail the ends first, then nail about every 3 in. around base, using 2½-in. finish nails with the heads set in out of sight. This rope, having a greater diameter than the thickness of the base, forms a cushion which will not scratch the surface upon which the lamp stands. Felt is therefore not required for the base.

A variety of ropes and blocks are fastened to screw eyes or belaying pins in the fife rail, the upper ends being plugged into small holes in the bevel at the top of the mast. For contrast, make the blocks of black walnut. A rope may be used to operate the switch in place of the usual chain, if desired.

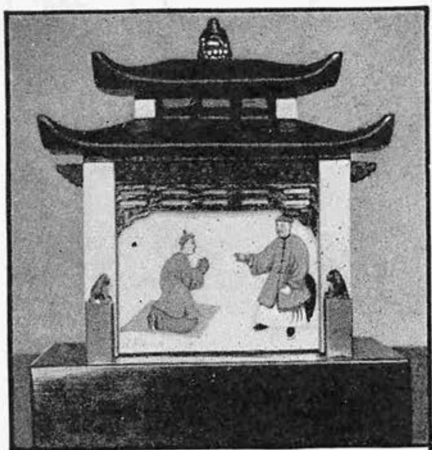
The shade in the illustration was homemade and painted in oils, but an appropriate one may be bought. It should be of good quality "parchment," 7 in. in diameter at the top, 14 in. at the bottom, and with a *vertical* height of 8 in. In place of the usual binding or fancy trim, this shade has an edging of 9-thread rope (5/16 in. in diameter), sewn on with straw color silk thread hidden in the twists of the rope.

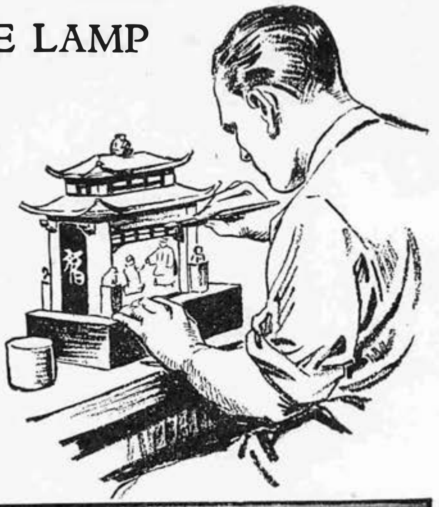
If you paint your own shade with oil colors, remember that you have two effects to consider: one when the lamp is lit, and one when it is out. White paint must be used thin; black paint, thick.

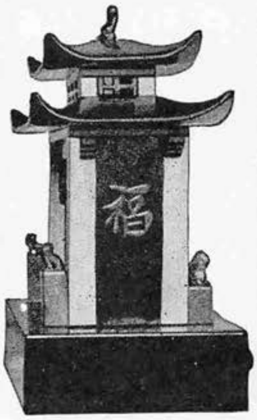
MEASURING WITH CIGARETTES

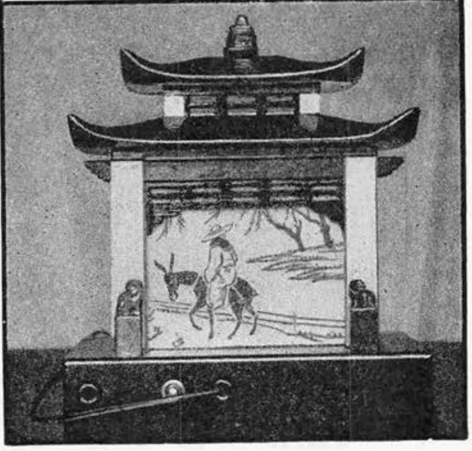
If no ruler is available, an ordinary cigarette makes a handy and fairly accurate measuring rod. All standard brands are 2¾ in. long, and because they are machine cut, the variation is less than 1/32 in. It is easy to estimate one-half the length, which would give 1⅜ in. Four cigarettes laid end to end measure 11 in.

SAWED-OUT CHINESE LAMP









Two translucent Chinese pictures mounted on glass form the chief decorations of this novel lamp

The light shines through the pictures as well as through the grill work above them and out between the roofs

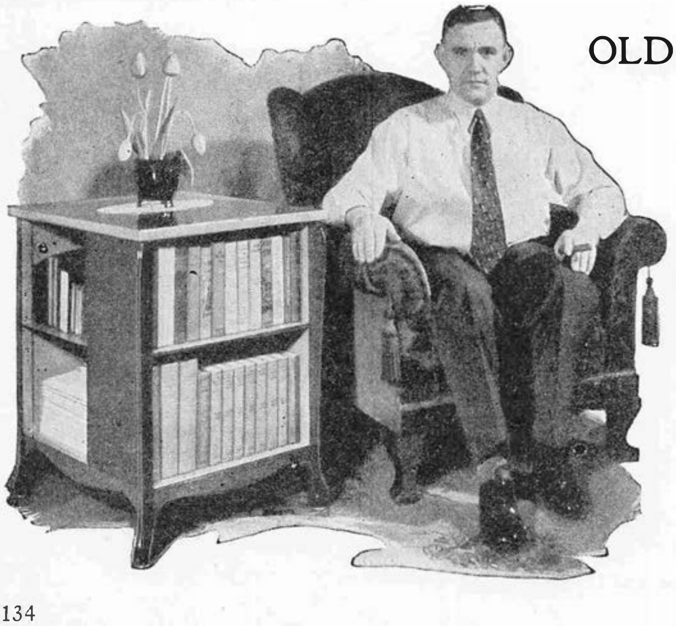
MADE almost entirely on a power jig saw, this oriental lamp stands 10¾ in. high over all and has a base 5½ by 9 in. The base contains a 110-volt candelabra lamp. The light shines through translucent Chinese pictures mounted on glass in the openings, front and back, as well as through the grill work just over the pictures and through the open grill work between the two roofs. The upper grill acts as a ventilator for the lamp.

The lamp is made of three-ply wood ¼ and 3/16 in. thick, except the roofs, which are cut from 1-in. cedar.

The roofs are cut out roughly with a hand scroll saw to give the curled effect at the corners. The undersides are smoothed with a sanding disk and the upper sides with a sanding drum. The grill work is cut from cigar-box wood. The lamp and electrical fixtures in the box which forms the base can be readily reached by the removal of the bottom board. The removal of two screws inside the base releases the upper portion of the lamp so that the glasses containing the pictures can be easily slid out, if desired.

These lamps make effective night lights, or they can be used purely for decorative purposes. They are lacquered in gay colors. The stone dogs and the bronze Buddha can be purchased at novelty stores.

OLD CABINET BECOMES END TABLE



This attractive, modern-looking bookcase end table made from an old phonograph cabinet is a simple and easy project. First cut off the top of the cabinet just below the sound chamber. Then cut out the right side, making the cut close to each corner and over the floor of the cabinet. This side is used for the new top. One of the doors is then put on the side in place of the part that had been cut out. The old shelves that formerly held records are used to make divisions for the present shelves. The winged corners are rounded to form a pleasing curve under the top.

An angle iron is used on each of three corners, and one is placed at the end of the door on the side to fasten the top to the cabinet. The mechanical part of the phonograph can be preserved unharmed.

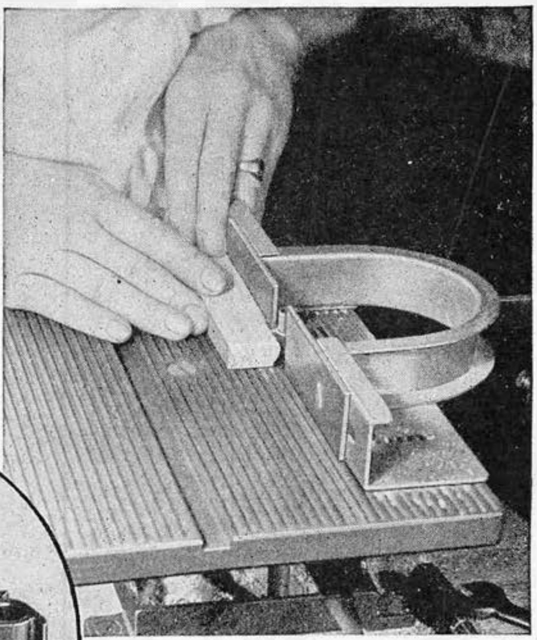
The height of the cabinet from the floor is 26 in. The top is 22¾ by 19½ in., and extends over the sides ¾ in. all around. The two front shelves are 8½ in. deep.

One white undercoat and two coats of light red enamel are applied to cover the saw cut at the edge of the top and also on the entire interior. The cost of the new materials is less than a dollar. This suggests other uses for cabinets.

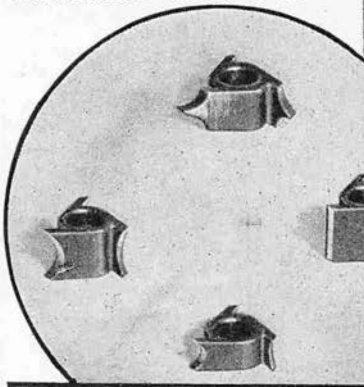
SHAPING

Picture-Frame Moldings

FROM SCRAPS OF HARDWOOD



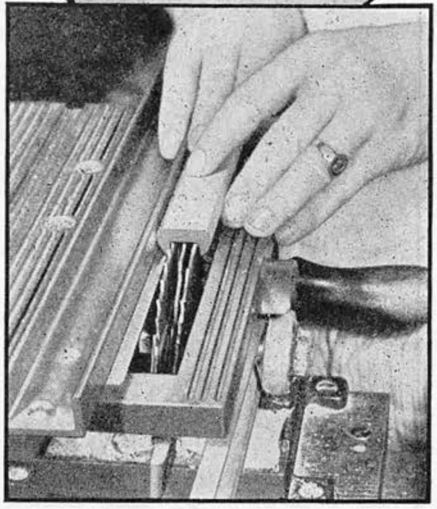
The double-width strips are molded on both edges with shaper cutters of the type shown at the left, which may be combined to give a variety of forms



ATTRACTIVE picture frames can easily be made in the home shop from scraps of valuable wood left over from furniture projects. The craftsman then has an opportunity to color or shape the molding to his own ideas of harmony and proportion, and the frames cost practically nothing.

The common practice of using a narrow strip of wood on the shaper is dangerous, and it is difficult to make an accurate cut because of the vibration of the wood. In the method to be described, a wider piece of wood is used. This keeps the hands away from the sharp cutters; the wood rests solidly on the table while being worked, thus insuring accuracy; and the only power tools necessary are a circular saw and small spindle shaper. Two strips of molding are made at one time, the only waste being that cut away by the saw and cutters. This saving is important when expensive or rare woods are used.

Before starting work, the size of the finished frame should be determined. The larger the frame, the wider the molding, both for strength and proportion. As an example, suppose a frame 8 by 10 in. is desired. For this size, molding about ½ by ½ in. will be suitable, therefore rip the strips ½ by 1⅛ by 24 in. (or they can be purchased from a lumberyard at small cost). It is important that the wood be uniform in width and thickness. The length, however, can be any convenient dimension that will cut to advantage.



The rabbet for holding the glass, picture, and backing is cut on the circular saw exactly as if it were a dado in the center of the molding

After the wood strips are prepared, the next step is to select a cutter, or combination of cutters, to give the shape wanted. By using the several cutters available, singly or combined, and by raising, lowering, or tilting the spindle, an unlimited variety of shapes can be made. When the cutters have been selected, lock them on the spindle and use a small straightedge (a 6-in. steel rule will do) to line up the front and back guides with that point on the cutters which will barely scrape the wood. In the case of a concave cutter, this will be the point on its arc that is nearest the spindle. This is to insure a uniform cut on the strip, and to avoid a taper.

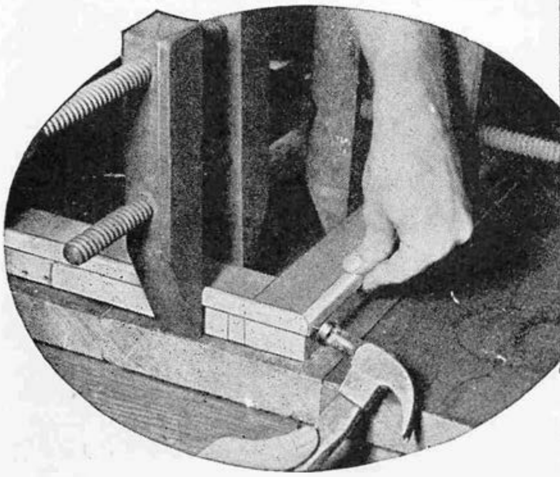
Have the spindle revolve about 10,000 r.p.m., and when more than one cutter is used, stagger the edges to give a smooth cut. Keep the strip pressed firmly against both the table and guides while feeding it past the cutter on one edge; and turn it around to do the same to the other. When starting the cut on the shaper, always begin about an inch from the end of the strip and pull the piece slowly toward you to reach the end, then push forward to complete the entire strip; otherwise the cutter may either knock the wood from your hands or split the strip.

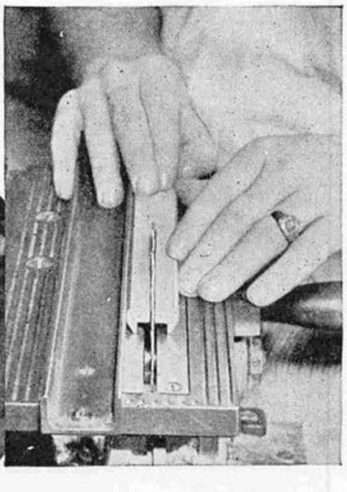
The next step is to cut the rabbet in which the glass and picture fit. On the circular saw, use the dado to make this ¼-in. deep cut, and set the fence so that the dado is centered in the piece of wood. If enough chippers are not on hand to make a wide enough cut in one operation, use what you have and run the strip through to cut slightly more than half of the rabbet; then turn it around and run it through again, as was done on the shaper. The latter method is better as the cut must then be the same distance from each edge.

After the rabbet is cut, it remains to rip the piece exactly in half on the circular saw, and the result is two identical strips of molding. Use fine sandpaper to smooth the strips, but be careful not to round off any sharp corners.

Miter four pieces of the molding to

The next step is to rip the strip in half, as shown at the right, to form the completed molding, ready to be mitered

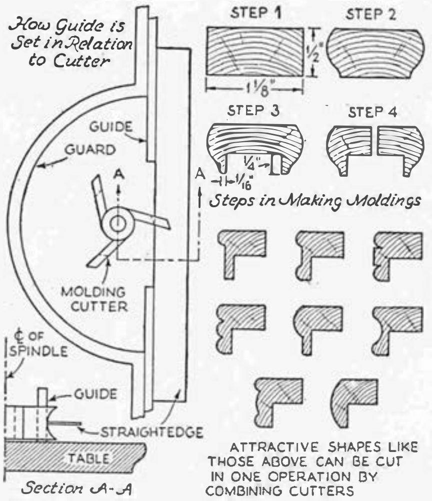




Two pieces of wood nailed at right angles to each other on the bench are used as a jig to insure squareness while the frame is being assembled the proper length—in this case two 8-in. and two 10-in. pieces. The set-up illustrated in one of the photographs will enable you to make accurately fitting joints. Two pieces of wood, about 2 or 3 in. shorter in length than the smallest dimension of the frame, are nailed to the workbench at right angles to each other. Apply glue to each of the edges of the molding to be joined, and clamp them tightly on this jig with the rabbet of each strip fitting snugly against the jig. The strip through which the nail will go should be slightly up on the other so that when the nail is driven home, it will slide down to make a snug joint. Fasten all four corners, wipe off any excess glue with a damp cloth, and set aside to dry overnight. When dry, stain the molding and rub on two coats of furniture wax.

Most pictures, especially of scenery, are more attractive if mounted with a wide border around them. It also adds to their appearance if the mount has been plate sunk. To do this, cut a piece of cardboard the same thickness as the mount, about 3/8 in. larger all around than the picture itself. Center this on the mount and turn both face down on a smooth surface. With the handle of a spoon or toothbrush, press firmly on the back of the mount and run around the card which is underneath.

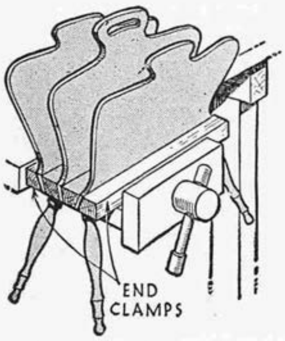
Cut to size and clean a piece of glass. Put it and the picture in the frame with a piece of corrugated cardboard in back, and hold tightly in place with small brads driven into the inside edge of the frame. Apply some rather thick glue evenly around the back of the molding and, when tacky, lay a piece of brown wrapping paper larger than the frame on it and rub into contact with the fingers. When the glue is dry, use an old razor blade to trim off the excess paper. This keeps dust from inside the frame. If this paper backing does not fit smoothly, rub a slightly moistened cloth over the whole area; as the paper dries, the evenness will disappear. Two small screw eyes and picture wire complete the frame.

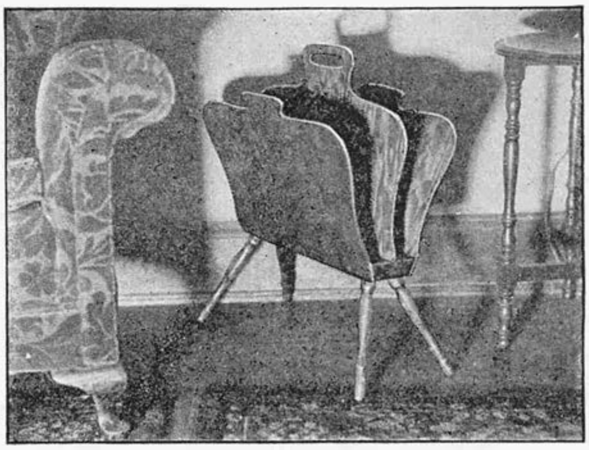


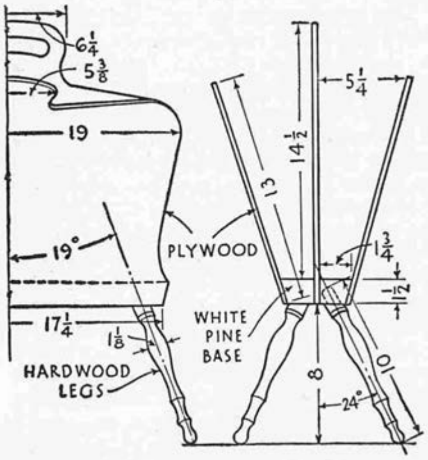
Method of setting shaper guide, the stock after each operation, and various moldings

SIMPLY CONSTRUCTED NEWSPAPER RACK

For those who are learning to use small woodworking machines, this rack will give practice in the easiest type of turning and sawing







A half side view (with over-all dimensions), an end view, and sketch of clamping method

BECAUSE of its unusually simple method of assembly, this newspaper holder can be made by anyone with a home workshop. The drawings show the approximate proportions and dimensions. The legs may be turned from any strong wood, even a discarded long shovel handle of hickory. The beveled base pieces were made from white pine and the panels from pine plywood. The plywood sides and partition should be cut so that the grain of the two outside plies runs up and down.

Glue is spread on the joints, and the pieces are nailed together with small finishing nails so that they will not slip. In order that the bottom may be clamped in a bench vise, two end pieces are beveled with the same bevel as the bottom pieces and used as shown to press against the joint.

SMALL LAMP HAS SECRET COMPARTMENT IN BASE

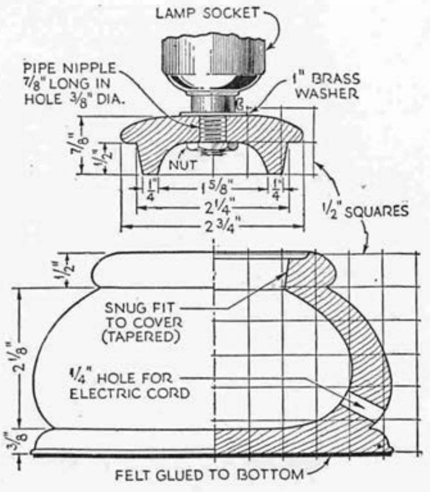
This lamp has a hiding place for trinkets

INCLOSING a secret compartment, this attractive turned lamp provides a case for jewels, trinkets, coins, or any small articles one wishes to keep hidden.

The base is turned from a block of black walnut 3 by 5½ by 5½ in., which may be glued up from three 1-in. pieces. If the block is glued up, align the pieces so that the direction of the grain is the same throughout. The cover is turned on a faceplate and made a snug, wedged fit. The screw holes by which it is fastened to the faceplate are hidden by the brass washer, which is peened before assembly.

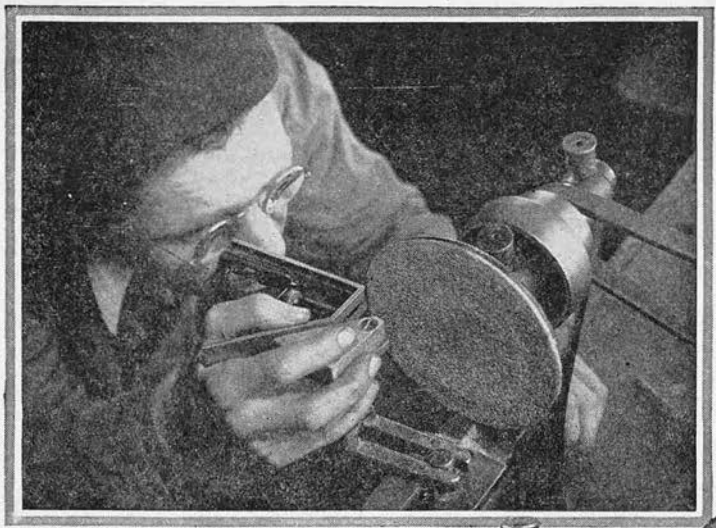
Almost any lathe-applied finish for walnut may be used. A coat of paste filler followed by several coats of linseed oil, rubbed in, will give a pleasing, dull gloss. Blotter paper may be substituted for the felt base. The shade may be purchased at a ten-cent store.

A lamp of this kind can be turned from woods of different colors, glued up as a block, to give a pleasing effect.



Drawings of the lamp base. Variations in the design may be worked out to suit yourself

A Quick, Accurate Way to Make PICTURE FRAMES



Sighting along the head of a combination square to set the guide block at 45 degrees to the disk

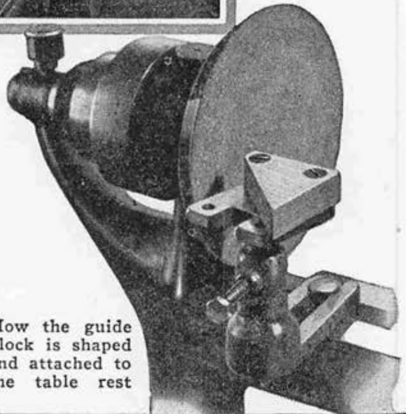
ONE of the many ways in which the home workshop may add to the income of its owner is the making of picture frames. By using the method outlined below, which involves the purchase of no extra equipment, the amateur woodworker can turn out a frame equal to the factory-made product and better than that usually offered by local picture framers.

There are three things that distinguish a well-made picture frame. First, the individual sides are accurately measured so that the frame will be a perfect rectangle when assembled. Second, the ends of the molding are cut at exactly 45 deg. so that the joints will show no V-shaped slots, the closing of which would tend to draw the frame out of shape. The cut is also perpendicular to the back of the molding, making the finished frame lie flat against the glass, and the surface of the cut is as smooth as possible to insure a close fit. Third, the corners are carefully joined and show no projecting edges along either end or the front of the joint.

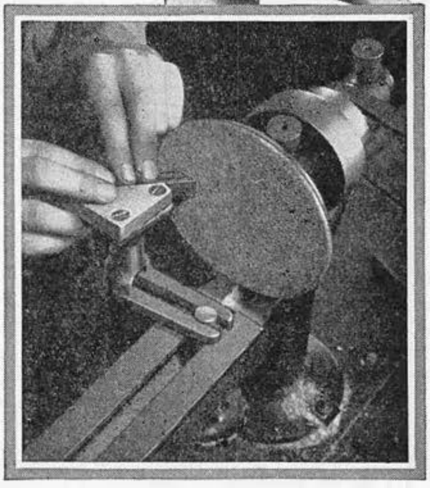
The first requirement should give no trouble to the amateur woodworker, who is accustomed to making careful measurements, but it might be well to remind him that all measurements are made along the inside back edge of the molding. It is with the second and third conditions that this article is chiefly concerned.

The molding is first measured, then sawed slightly longer than the measured length and at an angle of about 45 deg. This may be done conveniently with a jig saw, but if one is not available any other fine-cutting saw may be used. The next step is to sand each end of the molding down to the mark showing the correct length, and at the same time give the end an accurate 45-deg. face. This is done on the lathe with the aid of a table rest fitted with a guide block, which is merely a small piece of hardwood cut to fit the table rest as shown in the illustrations.

The 45-deg. face of the guide block must be made at a perfect right angle to the surface of the table rest, which is best done by sanding before it is fastened to the table rest. The final adjustment is made by using as a standard any accurate 45-deg. angle, such as the head of a combination try- and miter-square. By holding one side against the face of the guide block and sighting along the other side and the face of the sanding disk, the guide block can be set very accurately and locked in place with a set screw on the table rest.



How the guide block is shaped and attached to the table rest



With the aid of the guide block, the end of the molding is sanded to give a perfect joint

When this is done, it is a simple matter to hold the molding on the table rest against the face of the guide block and sand the end down to the marked length more accurately and with a finer finished surface than can be done with a saw.

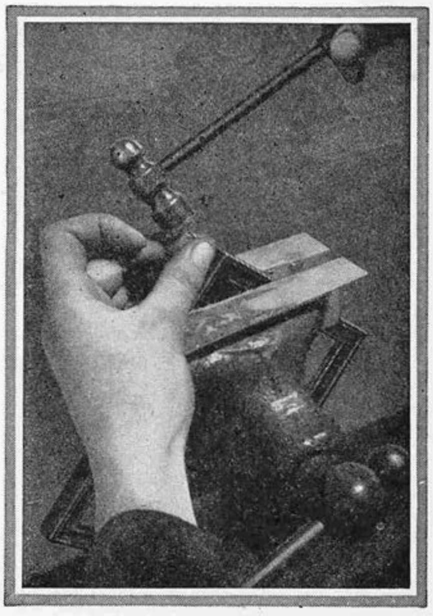
One trouble that must be guarded against is the damaging of the finish on the molding near the edge of the cut. Some types of finish are quite sensitive to heat, and if overheated by sanding on a worn disk will show a crimped effect along the edge of the cut.

When working with dark molding, it is wise to blacken or stain the surface of the cut before assembling the frame, since even a very small fraction of an inch of bare wood exposed at the joint would be quite conspicuous. Pressing the end of the molding on a well-inked stamp pad will do it quickly and satisfactorily.

The final operation of assembling requires an ordinary bench vise, the jaws of which are lined with cardboard to prevent marring the finish of the molding. The corner to be nailed is placed between the jaws of the vise, the two adjacent sides set so as to form a joint as nearly perfect as possible, and the vise tightened to hold them firmly in place. A small nail driven through each end of each side of the frame into the adjacent side will hold the frame together quite satisfactorily, but a stronger frame can be made by gluing the joints in addition to nailing them.

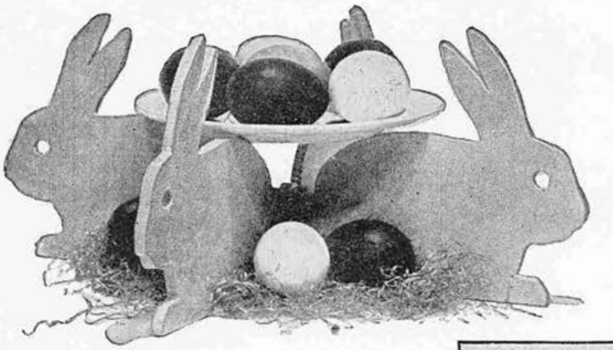
The sanding disk previously mentioned may be a commercially made one or, as in the illustrations, homemade. In either case it will be useful for many other purposes in addition to that mentioned here. The guide block, since it can be set at any desired angle, may also be used for other purposes.

Besides making frames for himself and his friends, the amateur woodworker may be able to make arrangements with a local department or novelty store to sell his frames or take orders for complete framing jobs.

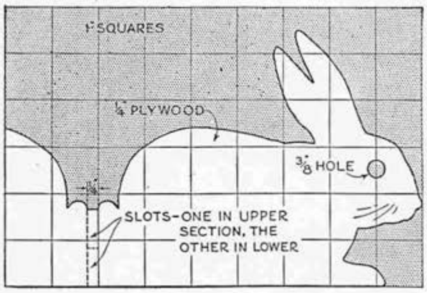


An ordinary bench vise, its jaws lined with cardboard, holds the frame while being nailed

Jig-Sawed Bunnies Hold Easter Eggs



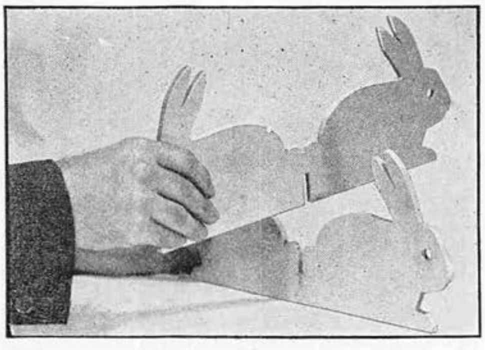
A colorful center decoration for the Easter breakfast table. Green tissue-paper grass is heaped around the holder for additional eggs



FOUR jig-sawed bunnies set up as shown make a novel stand to hold a plate filled with brightly colored Easter eggs. The whole forms an attractive center decoration for the table. Green tissue-paper grass may be placed in the angles between the rabbits, and a few eggs nested in the grass to add to the realism and Easter atmosphere of the setting.

The rabbits are cut from two pieces of ¼-in. plywood. First, prepare a full-size outline of one by sketching it on a piece of heavy paper on which 1-in. squares have been drawn. Cut this out as a template for outlining two bunnies on one piece of plywood. Then, if the two pieces of plywood are tacked together, both sections of the support may be sawed out at one time, with the exception of the slots at the center. It will be noticed that one slot is sawed in from the top, and the other from the bottom. Be sure that the slots are the right width to form a tight fit when the two pieces are engaged.

The eyes are indicated by boring ⅜-in. holes. Flat white paint will give a satisfactory effect, with whiskers painted on lightly, if you wish to add them.



The two parts of the holder are cut as shown at left, then assembled as above with a half-lap joint

BOOK ENDS DEPICT CAT-AND-DOG FIGHT

Novel garden-gate book ends decorated with jig-sawed cat and dog engaging in argument

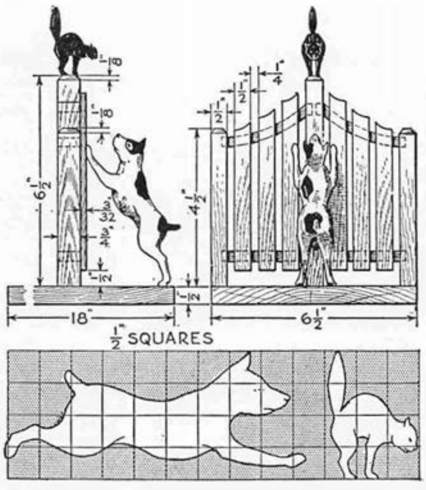
DO YOU remember the old gatepost that was always the favorite refuge for Blackie, the cat, whenever Towser came in sight? You can reproduce that old familiar scene in miniature form as a book rack for the den.

A hardwood such as walnut should be used for strength. The base is ½ by 6½ by 18 in., or any length to hold your favorite books. The other materials required are 4 pc. ¼ by ¾ by 3¼ in. for upper rails; 4 pc. ¼ by ¾ by 3 in. for lower rails; 2 pc. ½ by ¾ by 6½ in. for center posts; 4 pc. ½ by ¾ by 4½ in. for end posts; and 6 slats 3/32 by ¼, 2 being 4¼ in. long, 2 others 5 in., and the longest ones 5½ in.

Patterns for the dogs and cats are drawn and transferred to white pine blocks, and the profiles are sawed on a scroll or jig saw. The bodies are then partially finished by tilting them and sawing the curves of the back and sides and by cutting out the wood between the legs, between the ears, and removing the surplus from each side of the tail. The finishing is done on a spindle sander made of a ⅜-in. dowel rod covered with sandpaper and gripped in the drill-press chuck.

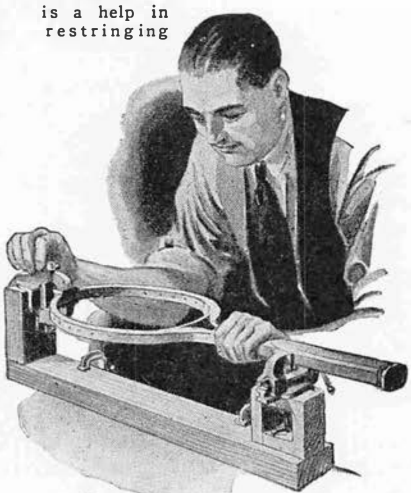
For painting the animals, an enamel will give a surface that is easy to clean. The gateposts are finished in dark brown, as is the center portion of the base. The ends of the base where they extend out beyond the fence may be enameled green to represent grass.

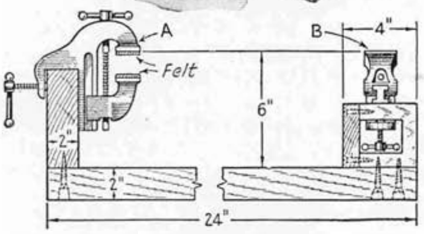
When the finish has dried, the cats are fastened by slender brads through holes drilled through the front shoulders. The dogs are merely cemented.



The assembled book end and patterns on ½-in. squares to aid in laying out the cat and dog

This tennis-racket vise is a help in restringing



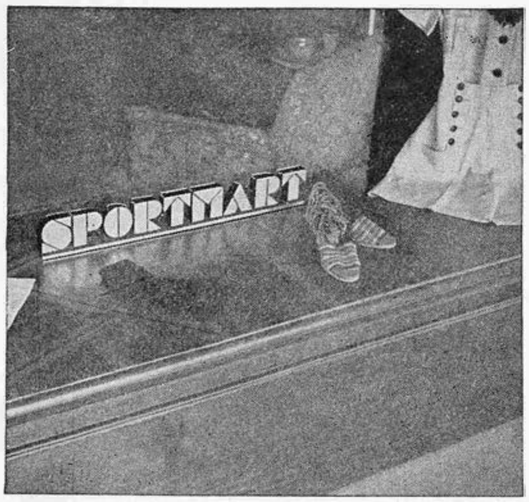


INEXPENSIVE VISE FOR STRINGING RACKETS

A SERVICEABLE vise for restringing tennis rackets can be made as shown above from a few scrap pieces of 2 by 4-in. wood and two small inexpensive vises of the type sold in ten-cent stores. The base is 2 ft. long. The upper jaw *A* of one vise and the top *B* of the other vise should be 6 in. above the top of the base. The dimensions of the opening in the hollow upright therefore depend upon the size of the vise. Each upright is secured to the base by three 3-in. screws countersunk into the bottom of the base.

Felt should be glued to the inner surfaces of the jaws of both vises. The whole vise can be attached to any solid table or to a workbench by means of two C-clamps.

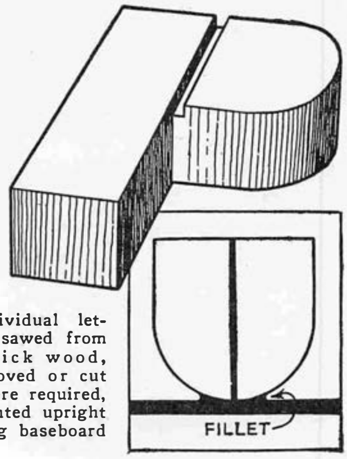
Simplified Alphabet
for Jig-Sawing
MODERN WINDOW SIGNS



THE novel sign illustrated in the photograph above was originated and built by a home craftsman for use in the window of a smart California shop. It has earned so much favorable comment that the method and special alphabet are offered here for the pleasure and profit of other homeworkshop enthusiasts.

Signs of this kind are easily made with a band, jig, or coping saw and a few other tools found in any shop. A piece of lumber 1 in. thick of sufficient size will be necessary. White pine is suitable because it is so soft and easily worked.

Lay out the necessary letters on the board, following the proportions shown in the drawings as closely as possible. The dimensions marked *X* will be determined in each case by the size of your letter. For example, if you want the letter *A* to be 4 in. high, then *X* equals 4 in. The other dimension shown would then be 1⅛ times *X*, or 1⅛ times 4, which equals 4½ in. The letter *A* will therefore be 4 in. high by 4½ in. wide. Where no dimensions are shown, the letters are square.



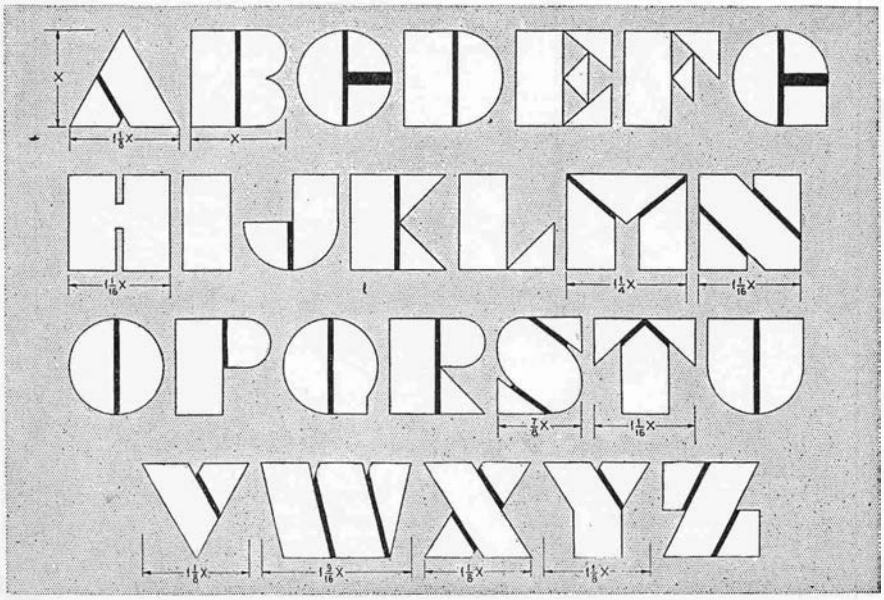
The individual letters are sawed from 1-in. thick wood, then grooved or cut back where required, and mounted upright on a long baseboard

On such letters as *O* and *U* it will be necessary to leave a fillet at the bottom, as in one of the detail drawings above. This makes possible the use of a straight line at bottom, and enables the letters to be mounted on the base to be described later. Letters like *E* and *F* also require fillets for strength.

Check the layout and if it is correct, saw out the letters, keeping the edges as true as possible. The black portions shown in the drawings represent the cut-backs, or parts cut down from the actual faces of the letters to a depth of about ⅛ in. In making these cut-backs, use a sharp knife and a straightedge. Clean out these cuts with a small chisel and smooth the resultant grooves with the edge of a flat file. After these operations, the faces of the letters should stand out in bold relief. Sandpaper them carefully.

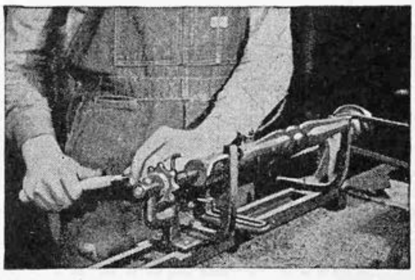
Now assemble the letters as they will appear in the finished sign in order to determine the proper length for the base, which should be 3 in. wide, 1 in. thick, and extend 1 in. beyond each end of the assembly. Cut the base and bevel the top edges. Mount the letters with glue and brads, or screws driven up from the bottom of the base. If preferred, the letters and base may be sawed from one solid piece of wood.

After mounting the letters, one or two coats of shellac will prepare the work for painting. When the shellac is dry, coat all parts except the faces of the letters with flat black paint. After this, in turn, has dried, paint the faces of the letters either gold or aluminum.



Modern alphabet for jig-sawing. After deciding the height of the letters, lay out the widths. Where no special width is indicated, make the letters square. The heavy lines represent grooves

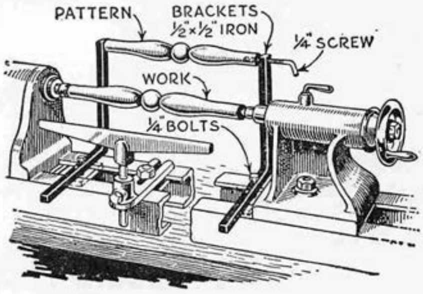
PATTERN FOR TURNINGS MOUNTED ON LATHE



A turned master pattern is mounted directly behind the work to guide in making duplicates

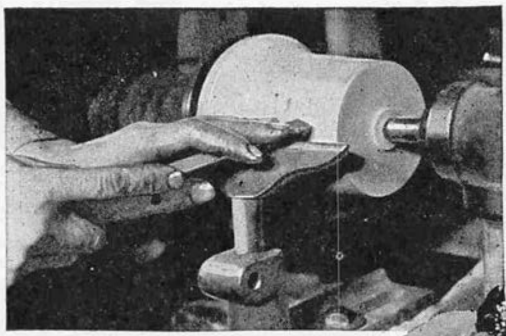
AMATEUR craftsman often have difficulty in making several turnings that are exact duplicates. By making two simple brackets, like those shown in the drawing, and fastening them to the lathe bed, a support is provided for a sample piece of work directly in back of the piece being turned. It is therefore possible for the operator to bring the work to approximate shape by eye, and to make comparative caliper readings quickly.

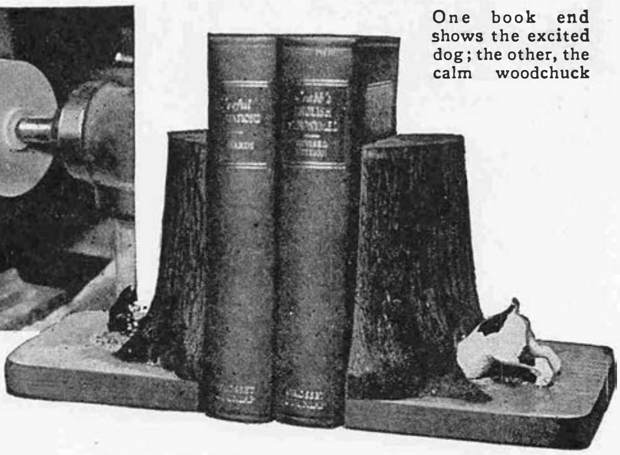
The size and shape of the brackets will vary with the make and size of lathe. The ones shown were bent from ½-in. square rod, with ¼-in. screw adjustments for centering. Fasten them to the lathe bed in any convenient fashion, but remember that it is bad practice to drill holes or otherwise alter a lathe bed. It is much better to use a clamping arrangement similar to that on the tool rest of the lathe.



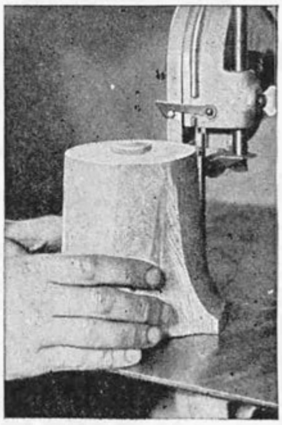
How the pattern is set on brackets, which may be of any shape and size to fit the lathe

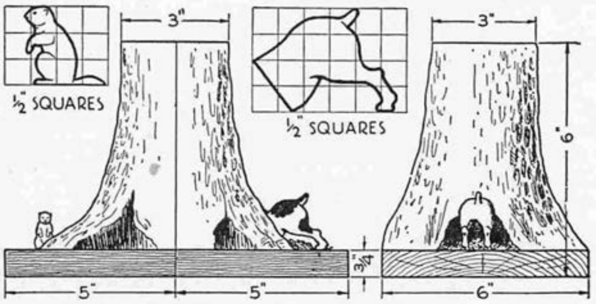
Novel Book Ends in Form of Tree Stump





One book end shows the excited dog; the other, the calm woodchuck





Two operations are shown in the photos—how the stump is turned to shape and how the recesses between the roots are cut on the scroll saw. Suitable dimensions are suggested in the drawings

"YIP, yip, he's in there," yelps Jiggers as he digs furiously away under the roots of the old stump. In the meantime, Chukky woodchuck is sitting out in the open on the other side and saying to himself, "I wish that fool pup would quit stirring up a dust in my house."

You can reproduce this old, familiar struggle in an amusing way on a pair of novelty book ends like those illustrated. To make the stump, you will need a piece of soft pine 6 by 6 by 6 in., or a similar block glued up from thinner pieces. Put the block in the lathe and turn the stump to shape, with a flare at the bottom for the roots. Then, using the scroll saw, cut the recesses between the roots. Saw the stump in halves and mount each on a base of 1-in. lumber.

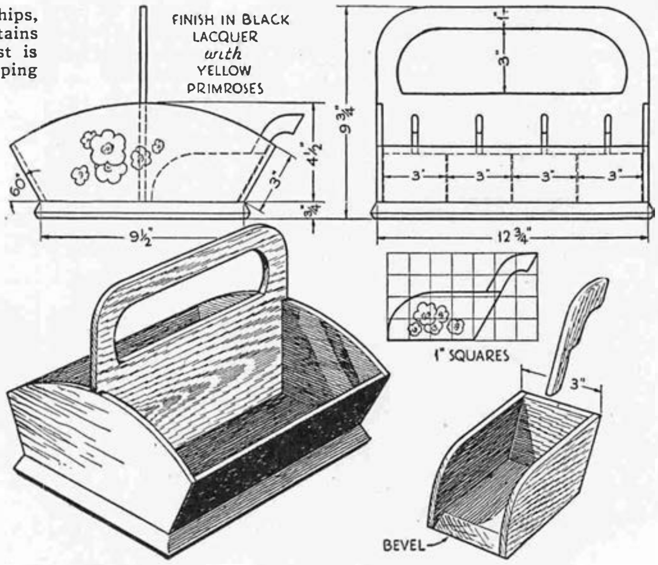
After the ends have been assembled with screws, the woodchuck hole is cut under the edge of the stump with a gouge. A pile of wood composition or sawdust and glue is placed around each opening to resemble the dirt. If you wish to extend the tree roots out farther, they can be formed of the same material.

The animals are cut from small pieces of soft pine. The final finishing can be done with a sander spindle made from a dowel and rotated in the drill press or, better still, in a flexible shaft. The body of the dog is pushed down into the hole so that only his hind legs and a small part of the back show outside.

For finishing, roughen the stump to resemble bark. This can be done with a wood rasp turned crossways and rubbed up and down the stump. After it has been brushed down with a steel wire brush to remove loose wood splinters, it should be stained dark and then brushed over lightly with dark gray paint to give it a gray color on the high lights. The dog is given two coats of white enamel and then the spots of black are painted on. Chukky is given a coat of brown stain, and his underside brushed with white paint. He is fastened by a small nail or pin driven down through the body into the baseboard. The base around the tree is either stained brown to represent earth or painted green for grass.

POPCORN SERVER HOLDS EIGHT SMALL SCOOPS

Designed for serving popcorn, potato chips, and similar appetizers, this bin contains eight individual scoops. Each guest is therefore able to take a good-sized helping



THIS bin with its eight scoops provides a unique and appetizing way to serve popcorn, potato chips, and similar titbits. The eight scoops fit neatly in the bottom of the tray, which is then filled with corn or chips, and the guest merely lifts out a scoop already filled.

The project is scroll-sawed from ¼-in. plywood, except the base and the scoop handles, which are thicker material. Cut out the various pieces and give them a thorough sanding on both sides. This is important because the beauty of the completed article lies largely in its glossy lacquer finish. Brads and casein glue are used at all joints. It is a good idea to apply one or two undercoats before assembling. Rub with fine sandpaper or steel wool before giving the final coat of lacquer.

A black background with bright yellow primroses makes an effective combination, or cream with blue flowers.

JIG-SAWED STARS FORM COLORFUL

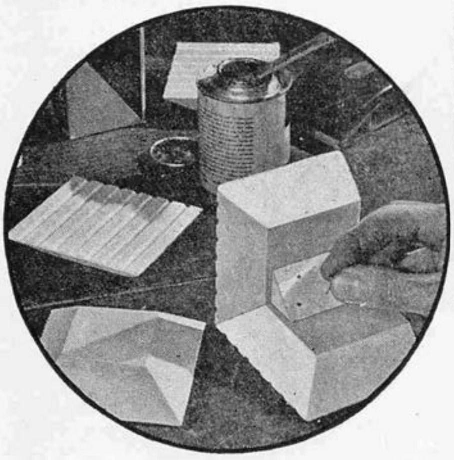
Christmas Candle Holders

THE jig saw and the candle joined hands to produce these colorful Christmas novelties. The modernistic, tree-shaped candelabra and the various star-shaped candle holders may either be set on a mantel or used to dress up the Christmas dinner table, but wherever placed they will add a gay and unique note to the Yuletide decorations.

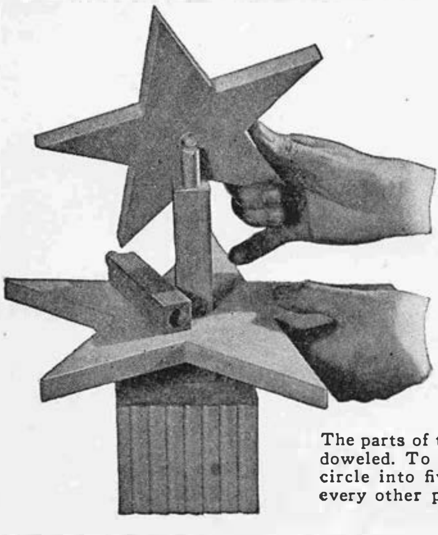
Stars or similar forms are the foundation for all the designs. They can be cut from wood ranging in thickness from ¼ to 1 in., or from sheet aluminum or other metal. A band saw or a handsaw can be used instead of a jig saw in most cases.

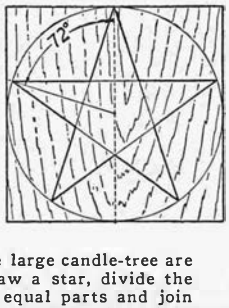
One of the easiest ways to lay out a five-pointed star is to draw a circle and divide it into five equal parts, using a protractor or the trial-and-error method. Then draw straight lines connecting every other division point.

The modernistic candle-tree consists of three star-shaped pieces mounted on a base and spaced by uprights of square or round cross section. Near each point of the two large stars, and in the center of the small one, are candles, eleven in all.



Assembling the base of a tree-shaped candle holder like that shown at the right of this page. Solid wood can be used if you prefer



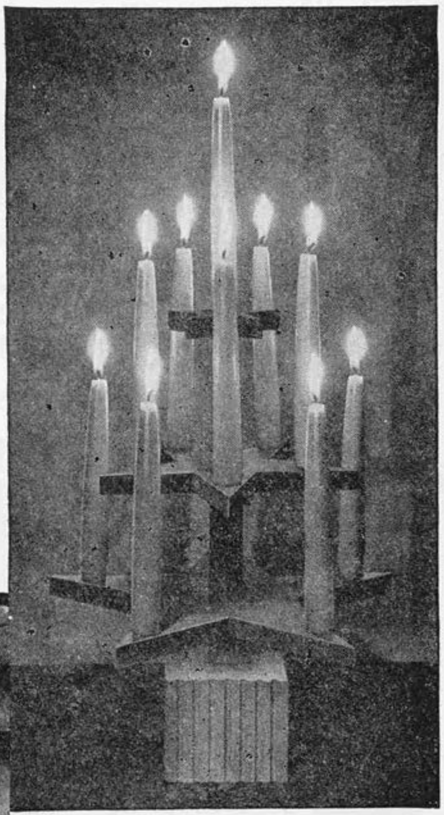


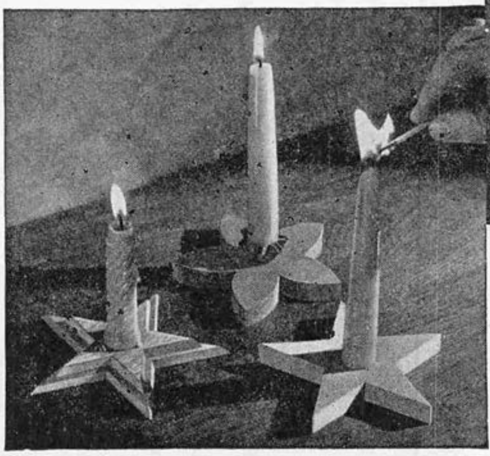
The parts of the large candle-tree are doweled. To draw a star, divide the circle into five equal parts and join every other point with straight lines

The base is 4 in. square and 3½ in. high. You can cut it from a solid block of wood, build it up by gluing 3½ by 4 in. blocks together until their combined thickness is 4 in., or make it from five pieces of wood whose joined edges are cut on a 45-deg. miter. The latter method is illustrated. In this case the surfaces of the sidepieces were grooved to increase their attractiveness, but this is not necessary.

The lower star is cut from a circle 12½ in. in diameter; the middle one from a circle measuring 8¾ in., and the upper one from a 4-in. circle. The material should not be much more than ½ in. thick.

The upright between the base and lower star is about 1⅛ in. square and 1½ in. long. The one between the lower and middle star is 1 in. square and 3½ in. long. The remaining upright is about ¾ in. square and approximately 4½ in. long.





A holder for eleven candles made in the shape of a modernistic Christmas tree. *At left:* Three individual candle holders

The candles should be 6 or 7 in. long when new. A simple and effective way of mounting them is to drive slender nails through the two larger stars, from the underside, about 1½ in. from each point, so that the nails project upwards for about 1 in. To prevent splitting, it is wise to drill holes slightly smaller than the nails. A nail with its head removed is driven into the center of the topmost star to support the upper candle.

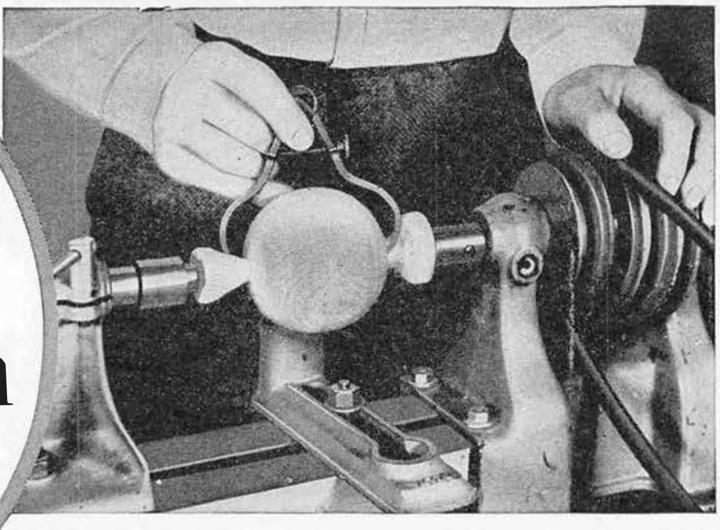
The parts are held together by ½-in. wood dowels glued in place. Bore ½-in. holes through the centers of the stars and into the ends of the upright pieces for a distance of about 1 in., and also in the center of the base. Before assembling, lacquer the stars a brilliant green and the base and uprights red. Arrange the stars so that the candles of one will project upward between the points of the next one, as illustrated.

The simplest candle holder is a star sawed from ¾-in. wood and lacquered some brilliant color or color combination. The candle can be held by a nail, set in a hole bored in the center of the star, or inserted into a little cup formed from sheet copper or lead. Incidentally, if you use nails for holders, you will find that the candles slip into place easier if the nails have been heated with a small torch or candle flame.

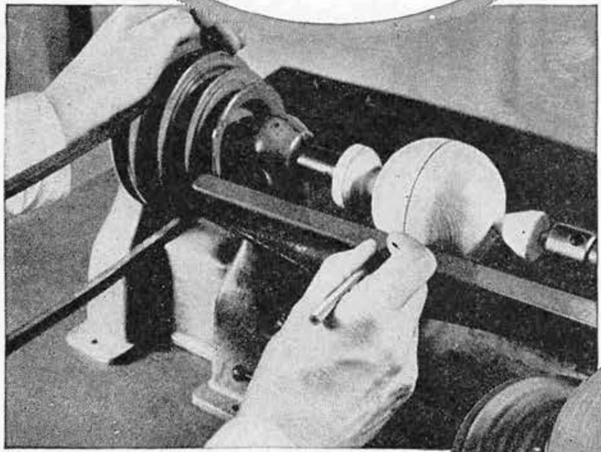
Another form of candlestick consists of two or three stars of progressively smaller sizes, mounted one on the other, and each painted a different color. Fancy woods can be combined and finished to show their natural grains. For variation, you can cut the star edges on an angle. In doing this, you will find the jig saw almost indispensable. Tilt the table and use a slender blade that will enable you to turn corners easily. For straight cuts with a level table, a wide blade is better because it has less tendency to wander.

If you find that you will have too many stars scattered about, you can add variety by making candle holders or modernistic trees in some other form. As a suggestion, a candle base that has five points shaped like the petals of a flower is illustrated. A wood poinsettia with bright red petals and a yellow candle in the center would be particularly appropriate.

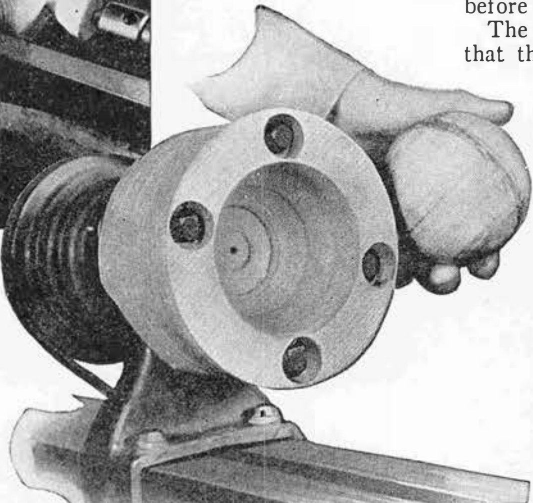
An Easy Way to Turn True Wooden BALLS



In making wooden balls for various bowling games, the stock is first placed in the lathe and turned to a diameter slightly larger than the finished size



Pencil marking the ball while the lathe is turned by hand. The work is then removed and the ends cut off. A wooden chuck is next made as shown at the right



THE craftsman who wishes to construct tenpins or other bowling games usually encounters difficulties when he attempts to shape the necessary wooden balls. No matter how much care he takes, they usually fail to roll true. The following method, however, will simplify the shaping of any size ball and enables a wood turner of little skill to make a perfect sphere.

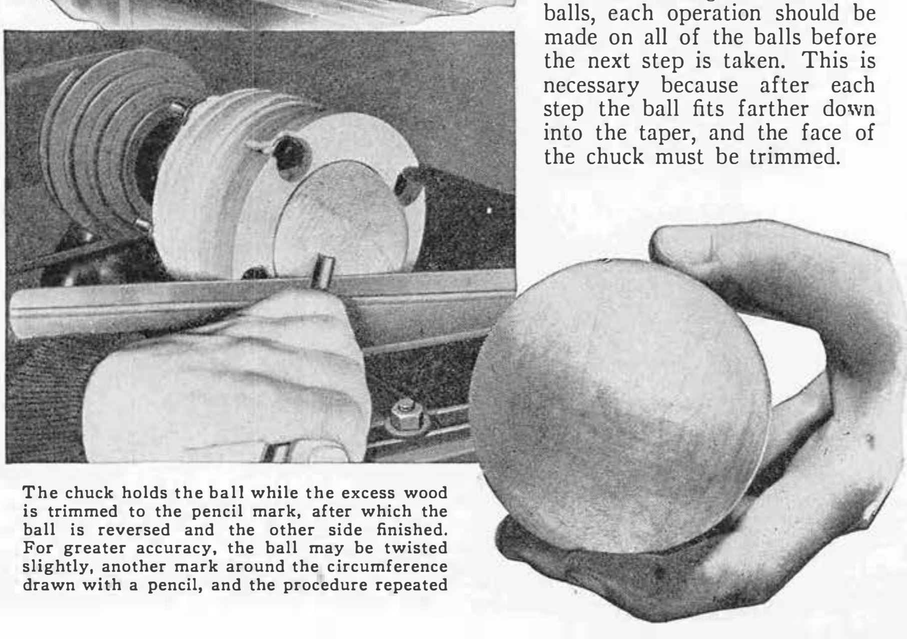
The stock is placed between centers on the lathe and turned to approximate size and shape. A caliper, used to test the ball, should be adjusted to a measurement slightly larger than the finished size. The ball is trimmed until it appears true and the caliper will just slip over it at any angle. A fine cut is then taken off the circumference, which will bring that part to a measurement a trifle larger than the finished size. The lathe is next turned by hand while a pencil is pressed against the ball to make a mark around its circumference. The work is taken from the lathe, and the excess end stock removed. A number of balls may be turned side by side from a single piece of stock.

A wooden chuck is required to hold the ball while it is being finished. Although the chuck is best made from a single block of wood, it may be built up of scrap material, in which case the direction of the grain of each layer should run at right angles to the grain of the piece next to it. The inside of the chuck, instead of being turned to the shape of the ball, is made on a slight taper. This will hold the ball securely and does not require the chuck to be altered after each trimming of the ball. An expansive wood bit set to the size of the bottom of the taper is useful for removing the wood from the chuck center before turning the taper.

The rough ball is placed in the chuck so that the pencil mark around its circumference is in a plane at right angles to the chuck as shown. The wood of the ball is then carefully trimmed to the pencil mark. The work is reversed, and the other side turned. If the work has been done carefully, the ball will be round.

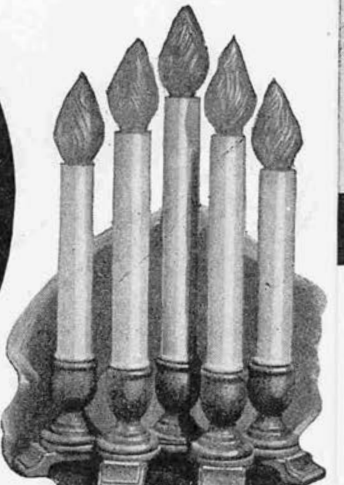
For the most exacting work, the ball may be turned slightly and another mark around the circumference made. The procedure is then repeated. The ball is sanded while still in the chuck. If the work is not too snug in the chuck, the ball's position may be shifted without halting the lathe.

When turning a number of balls, each operation should be made on all of the balls before the next step is taken. This is necessary because after each step the ball fits farther down into the taper, and the face of the chuck must be trimmed.

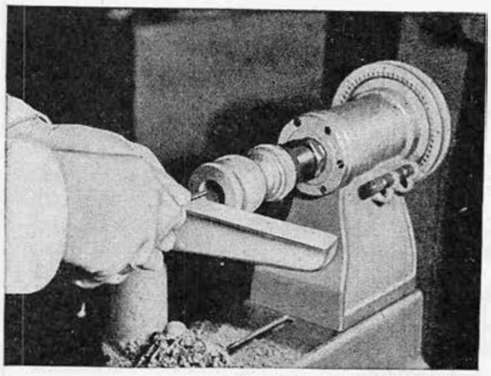


The chuck holds the ball while the excess wood is trimmed to the pencil mark, after which the ball is reversed and the other side finished. For greater accuracy, the ball may be twisted slightly, another mark around the circumference drawn with a pencil, and the procedure repeated

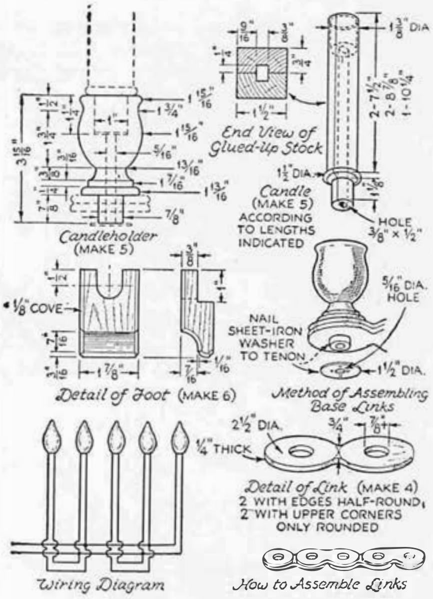
A Lamp of Seven Shapes

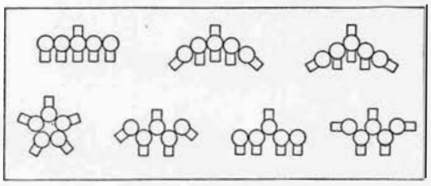


The feet of the individual candles are flexibly linked together. This makes it possible to arrange the candles in a circle as shown at the left, and in various groups like that below



The sockets for holding the wooden candles are bored by scraping in the holes from the ends with the lathe turning at high speed. Below are drawings of the candles, candleholders, and feet; details of the links and how they are assembled; and a simple way to connect the lamps





Diagrams showing the seven ways in which the candles may be arranged to form lamps

YOU will never lack a diversity of lamps if you build the candelabra pictured above. The five ivory candles with their linked holders may be arranged in seven distinct shapes to suit the available space or the mood of the moment.

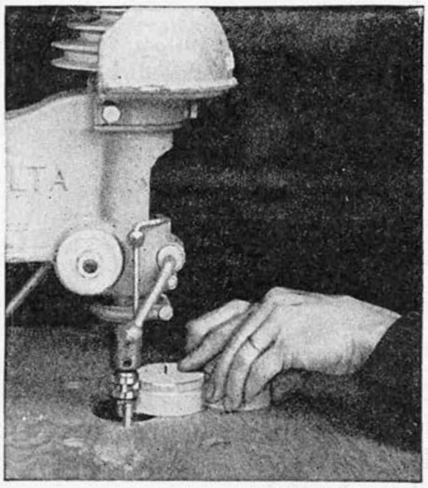
The candleholders are turned from walnut or mahogany stock 2 in. square in the rough. Cut blocks 4 in. long, with square ends, and carefully center them on a screw center for turning. It is advisable to bore out the sockets before the lower tenons are reduced in size, so that there will be ample base against the center flange to prevent vibration. If you have no inside calipers, turn a ⅞-in. plug template beforehand, and bore to fit, for the candles should go in snugly. When the turning is done, bore the wiring holes.

Stock for turning the candles can be glued up from 1-in. pine or hardwood. As electric wires are to run full length, the candles must be made hollow, and this is most easily done by grooving both pieces with a dado saw. Fit short plugs in the ends when gluing together; these will serve the double purpose of aligning the grooves and providing stock for the lathe centers. After turning, bore out the plugs and hollow the upper ends to receive the sockets.

The hinging together of the candleholders is accomplished by the use of four links consisting of pairs of circles, and two independent disks. When jig-sawing the links, round back the circles on tangents as shown to form necks ¾ in. wide. After boring for the candleholder tenons, make half-round edges on two of the links (those which are to go uppermost) and also on one disk. If this is done on a shaper, saw out a guide block of 1-in. stock to the same shape, and on top of this tack the link to be molded. The links used underneath have only the upper corner rounded.

Six feet are required for this lamp. They consist of forked blocks notched on the undersides as shown. An easy way to cut the 7/16-in cove in the front of a foot is to do it on a molding head used on a circular saw, with the end sliding against the fence, and the sides gripped in a hand screw. This gives ample holding power and keeps the fingers out of danger. The smaller coves are cut on a spindle shaper, or a drill press adapted for shaping. If you have no equipment for making moldings, omit this detail. The rest can be done with ordinary machines, or by hand.

The parts are finished before assembly. A satisfactory finish is to give the walnut parts one coat of thin white shellac and rub them down lightly with fine steel wool to remove any raised grain. Then mix a stiff paste of furniture wax and pumice stone and rub it well into all surfaces. When this filler has dried until the pumice shows white, wipe off across the grain with a cloth, and polish by rubbing. The antique effect thus obtained is very attractive. The candles are given three or more coats of ivory enamel, all undercoats being lightly sanded.



Using the drill-press shaper attachment to round the edges of the upper links, which are tacked to a template of thicker wood

To assemble, lay the candleholders in a row, and slip an upper base disk over the tenon of the one at the left. Link the next two, and then the last two. Now cut waxed-paper washers about ½ in. wider all around than the links and disks and force them over the tenons to prevent glue from reaching the upper links. The holes should fit snugly. Coat the tenons with glue, apply glue to the holes in the lower links, and put them on—a link over the two candleholders at the left, another link, and lastly a disk. This effectually joins the candlesticks together while permitting them to move to the shape desired. When the glue has dried, tear out the waxed-paper washers, and nail onto the ends of the tenons sheet-iron washers 1½ in. in diameter. Also glue the candles into the holders.

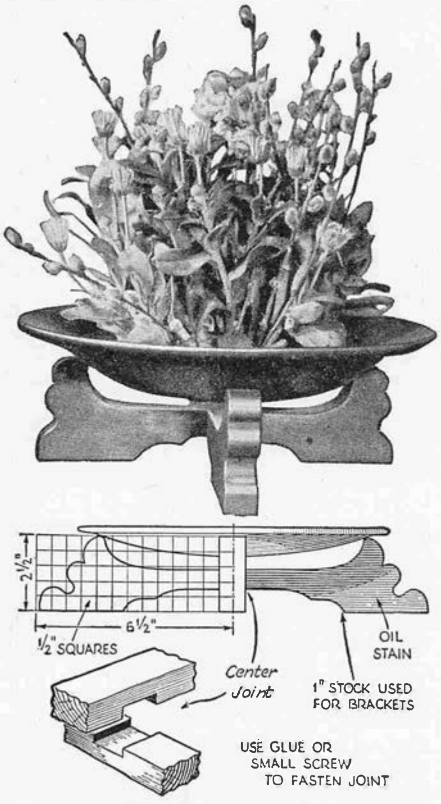
Use weatherproof sockets for the candles. Crack the composition shells with a hammer, strip off the pieces, and splice out the pigtails with short pieces of lamp cord. Tape the joints, threading the wire through the fixtures. Cut a jacket of heavy fiber paper to inclose the screw part of a socket and push it into the candle until it seats with the upper edge showing about ⅛ in.

One end socket can be connected directly to the cord for the lamp. The others must be spliced into this wire, but they can be connected in pairs, thus the insulation will have to be removed from only two places, instead of four, as would be the case if the sockets were separately connected. These joints must be taped and pressed as compactly against the underside of the base as possible. It is important to do a neat wiring job because of the movement between different parts of the lamp.

To set up the lamp, bend the base into the shape desired and push the foot forks over the tenons. The washers prevent them from slipping off the ends and turn them into sufficiently rigid mounts. They may be pointed in any direction desired.

A GRACEFUL HOLDER FOR SHALLOW FLOWER BOWLS

A GRACEFUL holder for raising a flower bowl a few inches from the table can be made from two pieces cut as shown in the squared diagram below, and joined in the center with glue or a screw. Finish the stand in dark oil stain or colored lacquer.


2½"
6½"
½" SQUARES
Center Joint
1" STOCK USED FOR BRACKETS
OIL STAIN
USE GLUE OR SMALL SCREW TO FASTEN JOINT

One of the flower-bowl supports in use and a drawing of the design, slightly modified

MOLDINGS MADE ON LATHE DECORATE SERVING TRAY

A serving tray lacquered blue, with scalloped border in yellow and black

Never Say a Job's Too Hard

SUPPOSE you wanted a tray like this, but did not have a spindle shaper for making the molded edge. Would you give it up? The originator of this idea didn't. He simply used his lathe for turning the moldings.

ONLY a lathe is needed to ornament the edges of this colorful tray. The segments of moldings glued around the base are cut from turned rings resembling round picture frames.

For the bottom scribe an 11-in. circle, draw eight equidistant radii, and strike arcs of 3-in. radius on a piece of plywood. If a bandsaw is at hand, and several trays are to be made, tack a dozen or more thicknesses of three-ply together with the pattern on top (nails driven into the waste wood), and cut the batch at one time. Sand the faces smooth, sponge with water to raise the grain, and sand smooth again when dry.

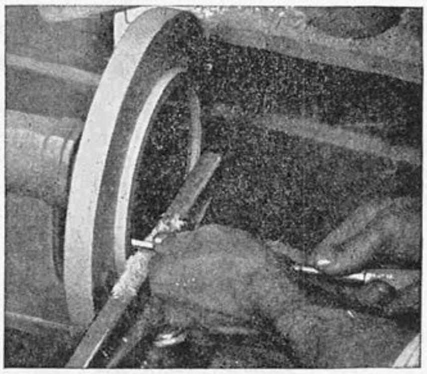
For a really fine paint job, brush on two coats of lacquer; and when dry, scrape level with a square-edged cabinet scraper, finishing with split 6-0 sandpaper used wet. Then give one more coat of color, to be rubbed down, first with the sandpaper, then with pumice stone and water applied with a felt pad.

While the bottom dries, make the moldings. Mount disks of wood on a faceplate for turning the fronts. It is necessary, of course, to be accurate in turning the profiles, so that the segments will match at the joints. When all are turned, saw out the waste centers.

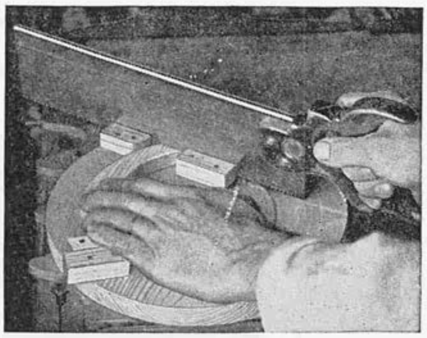
Make a chuck to hold the rings while the rabbets are being turned, and trim the insides. Scrape the rabbets with a ¼-in. chisel. The finished rings can be pried out of the chuck with a chisel pushed in behind at the end grain, since this part is later cut away.

Use the chuck, with the addition of guide blocks, as a miter box to cut the segments. Insert the half-rings with the rabbet out and the grain running the long way.

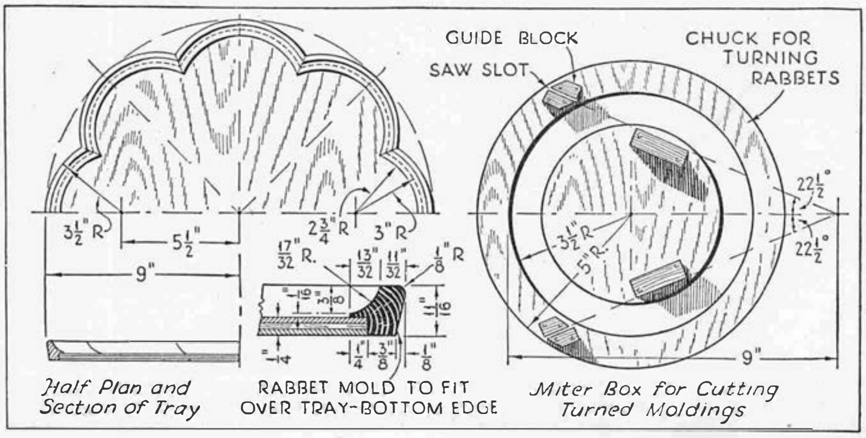
Scrape the paint from the bottom along the edges, exposing 3/16 in. of wood. If thick casein glue is used, the sections can be pressed in place, and no nailing or clamping will be required. Complete the tray by painting the molding as desired.



The rings are held in a wooden chuck for turning the rabbet and trimming the inside



Six blocks are then added to the chuck to make it into a miter box for the moldings



Half Plan and Section of Tray

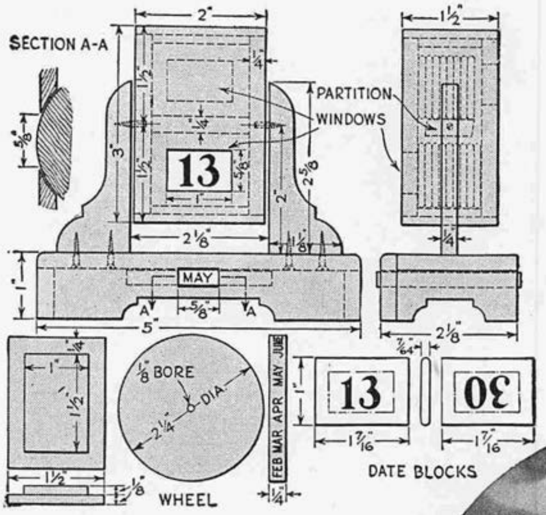
RABBET MOLD TO FIT OVER TRAY-BOTTOM EDGE

Miter Box for Cutting Turned Moldings

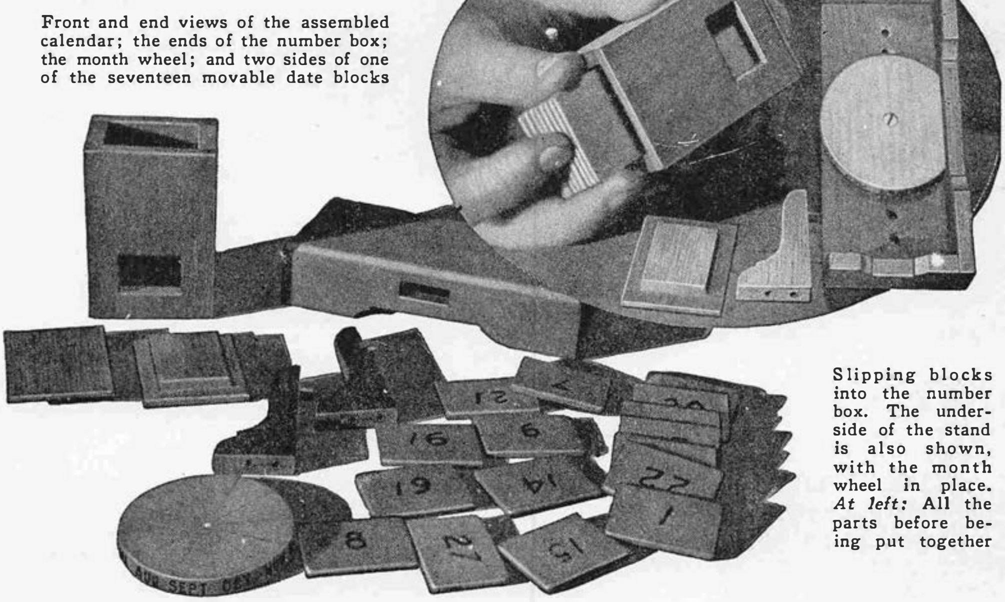
Unique Perpetual Calendar

Changes Date When Flipped Over

The next number comes in view automatically when the top of the date box is turned forward half a revolution. This is done by an ingenious system of sliding wooden blocks



Front and end views of the assembled calendar; the ends of the number box; the month wheel; and two sides of one of the seventeen movable date blocks



Slipping blocks into the number box. The underside of the stand is also shown, with the month wheel in place. *At left:* All the parts before being put together

TO CHANGE the date on this novel perpetual calendar, the pivoted box part is merely flipped over each morning so as to bring the rear surface towards the front. The new number then appears automatically in the window. This always interests and puzzles onlookers, although the mechanism is really quite simple—a series of seventeen blocks that slide up and down in a predetermined order.

Make the box first, preferably from a good cabinet wood. The windows may be left open or fitted with small glasses. If glass is used, be sure that the inside is flush or sunk a trifle. Assemble and glue the four sides with the windows at opposite ends. Leave the ends open.

For the blocks, make thin strips from a piece of white hardwood such as maple. Cut off nine very small pieces to see if their combined thicknesses will just fill the box. If so, cut seventeen blocks 1 by 1 7/16 in. and round all edges and corners.

The partition determines whether the calendar will work or not. Its ends, in the face view, fit tightly in the box. The edges, as shown in the side view, are beveled slightly and parallel to each other. The partition must be of such width that it allows enough space on each side between it and the box so that one block will pass through on each side at the same time. Glue or nail the piece in place, making sure it is accurately centered.

Try the number blocks to see if they slide correctly. Put eight pieces in one end of the box and nine in the other, as shown in the side view. Hold the ends of the box on and turn the box top toward you a half revolution. Do this about thirty times. If a block drops from the top in front of the window each time it turns over, you will know everything fits correctly. If the windows have been left open, draw a square the size of the window on each block as it drops down, and number these from 1 through 31. After 31 there will be three blank blocks. These may be left blank, pictures may be put on, or you may print the words "TURN SLOWLY" on them. The next number should be 1. If so, everything is correct. Remove the blocks from the box and paint on the numbers.

If the windows are covered with glass, you must number the blocks in the following order, a number on each side of the block. Invert the number on the backs, as shown.

1—18
3—20
5—22
7—24
9—26
11—28
13—30
15—Blank
17—Blank
19—2
21—4
23—6
25—8
27—10
29—12
31—14
Blank—16

Now you are ready to place the blocks permanently in the box. Arrange them in the following order with number 1 on top: 1, blank (with 16 on the back), 31, 29, 27, 25, 23, 21, 19. This group goes in the bottom compartment with number 1 showing correctly in the window. Now put the lower end on temporarily. The order of the other group is as follows from the top down: blank (with 17 on the back), blank (with 15 on the back), 30, 28, 26, 24, 22, 20. Set these in the other end with the first blank showing in the window. Place the upper end on the compartment temporarily.

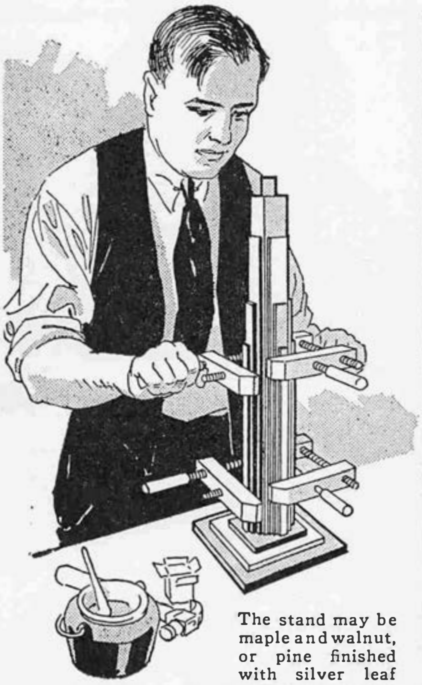
Now revolve the box, top end toward you. If the numbers appear at the windows correctly, the ends may be glued permanently. Be careful not to get any excess glue inside of the box, otherwise the blocks may stick.

The stand is made as illustrated. Cut an opening ¼ by ⅝ in. or longer in the front of the base for the names of the months to show through. Prepare a disk 2¼ in. in diameter from a piece of maple or other white hardwood ¼ in. in thickness, divide the edge into 12 sections, and paint on the names of the months. Fasten this in place with a small screw through the center of the disk.

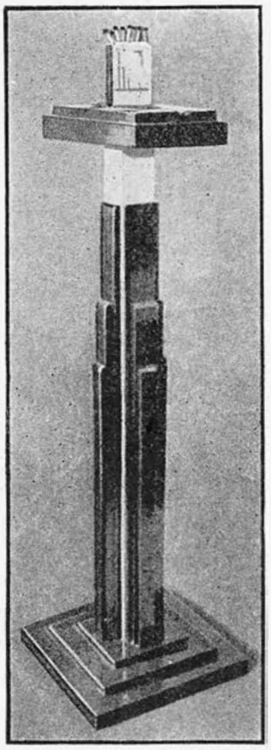
The pivots for the box are made from ½-in. screws with the heads ground to the same diameter as the shank. These are screwed into the upright supports 2 in. from the base and with 5/16 in. of the screw left showing. The box is now balanced and the pivot points marked. Bore small holes the size of the screw. Fasten one upright to the base, fit the box between the pivots, and fasten the other upright.

The calendar may be finished in any way you wish.

Modernistic Smoking Stand



The stand may be maple and walnut, or pine finished with silver leaf and black lacquer



IN THIS unusual smoking stand, the beauty of the setback skyscraper design is enhanced by the use of two or more contrasting colors in the finish.

First get out a center post 1½ by 1½ by 24 in. Turn down the ends of this piece as shown to fit 1-in. holes in the base and top (or cut square tenons if a lathe is not available). This post should be of light-colored wood or of pine covered with silver leaf. The remainder of the stand is of dark wood or pine lacquered black.

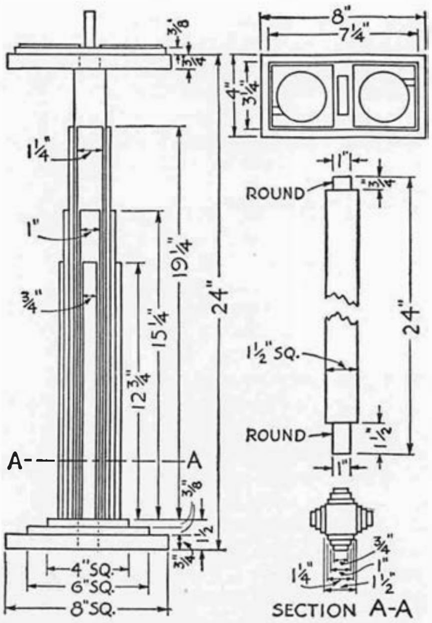
Make the base from one piece ¾ by 8 by 8 in., another ⅜ by 6 by 6 in., and a third ⅜ by 4 by 4 in. These are glued and bradded together. Bore a 1-in. hole through the center of the base, insert the center post, and glue it in place.

The twelve ¼-in. laths used to build up the setback effect are next sawed and planed to the dimensions shown, then glued and bradded in place on the center post.

Cut a piece ¾ by 8 by 4 in. for the top, and bore a 1-in. hole at the center. Set this on the post and fasten with glue, being careful to square it with the base. Now obtain two small individual ash trays such as are sold in sets at novelty stores. Cut a board ⅜ by 3¼ by 7¼ in. and, with a coping or jig saw, cut two holes to fit the bottoms of the trays. Glue this piece in place on the top. A suitable match box holder may be made or purchased and secured between the trays.

In laying silver leaf on wood, it is important that the wood be as smooth as possible. It is advisable to fill the wood with a paste wood filler, then sand it smooth with No. 4/0 sandpaper. Next give it a coat of good varnish thinned with turpentine. Allow this to form a hard, tacky surface before applying the leaf.

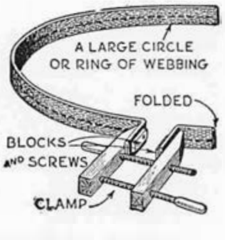
If two woods of contrasting color, such as maple and walnut, are used, finish the piece with white shellac, clear lacquer, or varnish.

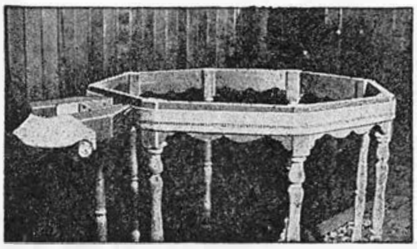


How the stand is assembled, a cross section, and details of the center post and top part

STRONG WEBBING HELPS IN CLAMPING JOINTS

IN BUILDING furniture that is not rectangular in shape, the problem of clamping is often difficult. To clamp an octagon-shaped table, get some furniture webbing, fold it through the center lengthwise, and fasten the ends to a hand screw with blocks and screws, leaving it long enough to reach around the framework when the clamp is open. While the glue is drying, a support is placed under the clamp.



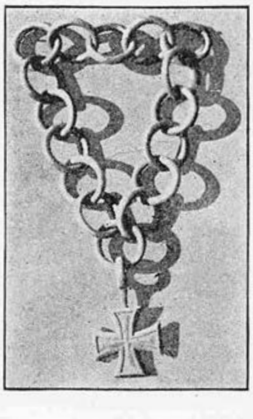


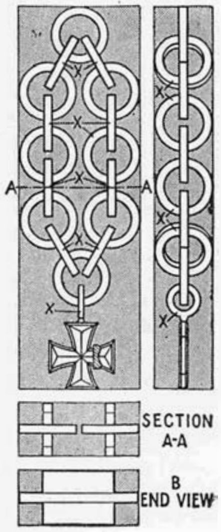
Clamping the framework of an octagonal table with a hand screw and band of heavy webbing

ENDLESS CHAIN CUT FROM ONE BLOCK

DIFFICULT as it looks to be, this endless chain and cross can be carved from one piece of wood by anyone who will go at it systematically and patiently. Get a straight-grained block 1½ by 3⅛ by 10 in., preferably mahogany or walnut. Mark both ends as shown at *B* and plane away the shaded parts with a rabbet plane. Mark off the rings *X*, eight of which are 1½ in. in diameter and one ⅞ in. in diameter. All are to be ¼ in. wide and ¼ in. thick. Cut down between the rings with a coping saw and chisel out the wood in between as shown in the edge view. You will now have what amounts to a board ¼ in. thick with nine half-round disks projecting on both sides.

Next mark off the other eight rings, which are all 1½ in. in diameter. This you can do with a pair of dividers. Don't cut away all of the wood outside the rings at one time—only sufficient to allow you to cut loose one ring at a time, otherwise the wood is likely to break. The last thing to cut out should be the cross, because it comes in handy to clamp in the vise while you cut the rings. After the rings are all cut loose from one another, round them nicely with a chisel and smooth with sandpaper. The cross can be left plain or carved out as shown. It is 3/16 by 1¾ by 1¾ in. Any type of ornament, of course, may be substituted.



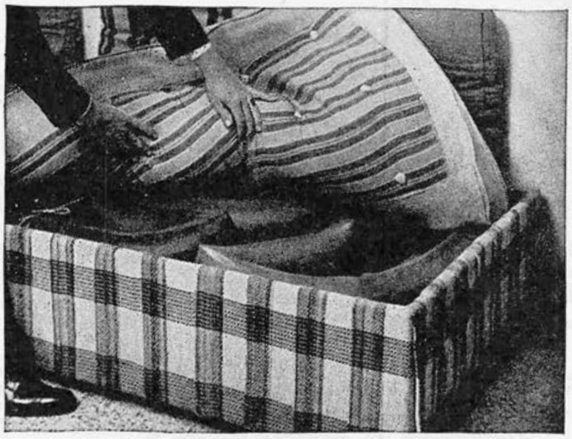


The completed chain and, at right, drawings in which the tinted areas show how the wood is cut away. The links could be cut oval instead of round

Studio Couch

Built at Low Cost with Old Inner Tubes in Place of Springs

This couch was built complete for less than $10, yet it compares favorably with commercial articles costing a great deal more



Five old inner tubes are sufficient to form the "springs" of the couch. They are tied in place with cords tacked to the bed

BY USING old inner tubes in place of upholstery springs, any amateur craftsman can construct an attractive, modern-looking, and thoroughly serviceable studio couch for a fraction of the cost of the commercial article.

The length and width may be varied, but the 16-in. height above the floor should be maintained because it insures the most comfortable knee position for the average person. The sides and ends are made of 1 by 8-in. boards. You will need, for a couch of the size shown, about 37 linear ft. The corners may be joined in any suitable manner—screws, straight nailing, tenoned joints, or even mitered joints.

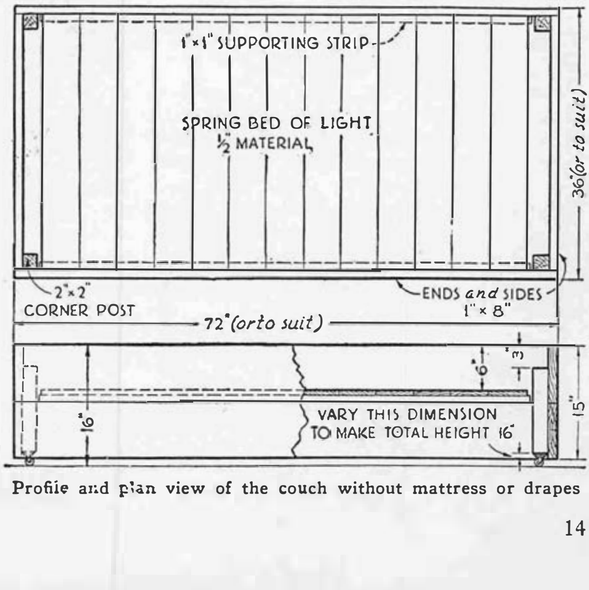
The corner posts are 2 by 2 by 12 in. Note that they are not set flush with the lower edges of the main boxlike frame, but are kept up a little. The roller casters are set into the recesses so formed, thus providing the proper height from the floor. This detail should be watched during construction, as casters vary in dimensions. I found the most satisfactory type to be one in which the caster and the attaching plate are a single unit.

Along the inside of both walls are nailed or screwed two 1 by 1-in. strips to support the bed. On these are laid crosswise slats of light ½ by 6-in. material, although any available widths of stock will do. The slats may be placed close together or separated a few inches for additional springiness. Their distance below the top edge should be approximately 6 in.

About five old inner tubes will be sufficient to form the "springs." They should be of medium size and inflated so that they are almost flush with the top edge. Arrange them on the slats in the best position to give uniform support to the mattress. To prevent them from shifting, pass a loop of strong cord around them wherever necessary and tack the ends to the bed. Use four or five of these cord stays for each tube.

The sides and ends of the couch are covered with any suitable material. The one in the photographs is finished with heavy curtain cloth, pleated, and fastened with upholstering tacks along the upper edge.

While it may be possible to devise a substitute for the mattress, it is fairly cheap to have one made to order. The one shown is 3 x 6 ft. and 4 in. thick. Covered with monk's cloth, the original was made up at a price of four dollars.



Profile and plan view of the couch without mattress or drapes

YOU CAN SAVE A LOT BY BUILDING THIS Beautiful

A chair of this quality is very costly, but any amateur craftsman can make one like it if he will take sufficient pains

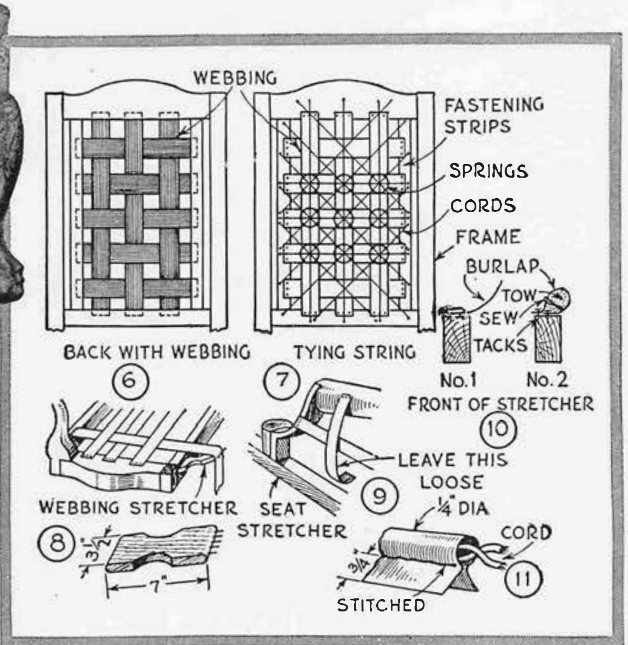
A WING chair is as comfortable and cozy a chair as can be bought, but the price of a good one is beyond the reach of many men who have, however, the skill to build one. In designing this project, the best traditions of the chair maker's art, as practiced during the eighteenth century, were followed.

The front legs are carved from a piece of solid mahogany 3 in. square and 16½ in. long. Two blocks of mahogany, 2½ by 3 in. and 3½ in. long, are glued to each leg 2½ in. from the top to give sufficient stock for the flare. After the mortises have been cut and the blocks glued on, the legs are marked by means of a pattern cut from a piece of flexible cardboard. This is later used to make the stencil with which to lay out the carving on the leg (Fig. 4). The pattern is transferred to one side of the leg, which is then band-sawed. The adjacent side is marked for the next sawing. The leg is now shaped, but is still square in section (Fig. 5). It will have to be rounded with spokeshave, chisels, and file. In carving the foot, it is best to block out the toes and leave them until after as much as possible of the ball has been formed. When the toes are being carved, keep each knuckle the same distance from the floor. The carving on the knee requires time and care, but is not difficult. Outline the leaves with a V-tool, then cut away the background, and finally model the leaves.

No great difficulty should be experienced in constructing the rest of the frame, except, perhaps, the arm supports. They are made from hard poplar blocks, 3 by 5 by 11 in. First saw to the shape given in Fig. 3, then cut to the shape shown in Fig. 2. It may be necessary to fill out a place or two with an extra piece of wood to get the proper shape, as shown in the photograph of the frame.

The finish on this chair consists of a coat of oil stain, a thin wash coat of shellac, and two coats of varnish, rubbed down with pumice stone and oil.

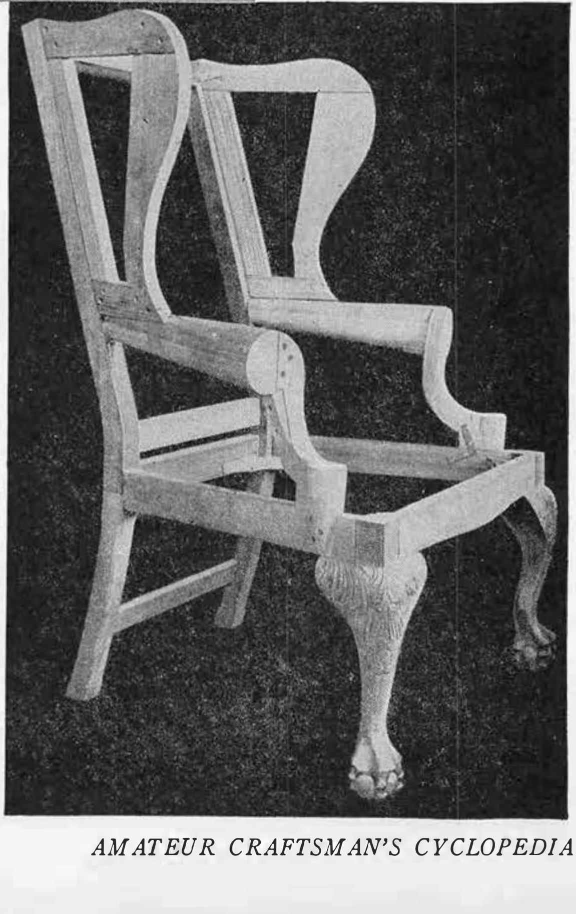
To upholster the chair proceed as follows: Tack good hemp webbing to the bottom of the seat frame, to the outside of the back, and to the inside of the arms and wings. The webbing must be interwoven, stretched, and tacked with 12-oz. tacks (Fig. 6). The webbing is first tacked at one end, then stretched as shown in Fig. 8, and tacked before being cut. Double the ends of the webbing over the first few tacks and tack through the double thickness. The vertical webbing on the inside of the arms is tacked to the outside of the seat frame, after the upholstering on the inside of the arms is all in place. It is necessary to leave it unfastened at the bottom so that the burlap, muslin, and upholstering material can be drawn down and tacked to the outside of the seat stretcher. When this has been done, the webbing may be pulled tight and tacked. By fastening the upholstering material, muslin, and webbing to the outside of the seat stretcher, the top of the stretcher is left free to tack the burlap and muslin which cover the springs of the seat (Fig. 9).



Diagrams showing the general method of applying the webbing and making rolled edges and welts. The complete framework is illustrated at the right

For the back of the chair, nine 4-in. pillow springs are sewed with twine to the webbing at the places where the strips intersect. Use an overhand stitch. Twelve heavier seat springs are sewed to the webbing in the seat. Tie the springs eight times with heavy twine (Fig. 7), using a weaver's knot. The twine must be stretched in such a manner that the springs may be compressed without tearing or loosening the twine where it is tacked. It must be taut enough, however, to hold the springs straight.

When tied, the springs must be covered with heavy burlap. About three yards will be needed. Pull it through the opening between the back legs and the vertical strips *A*, Fig. 2, and tack it with 6-oz. tacks to the back of these. After the filling material has been put on the back, the muslin which covers it and also the upholstering material are drawn through this opening and tacked in a similar manner. At the bottom of the back, the materials are drawn through the opening between the seat rail and the stretcher above the seat rail and tacked to the back of the latter. They are drawn to the back, to be tacked at the top of the chair. The webbing on the arms and wings must also be cov-



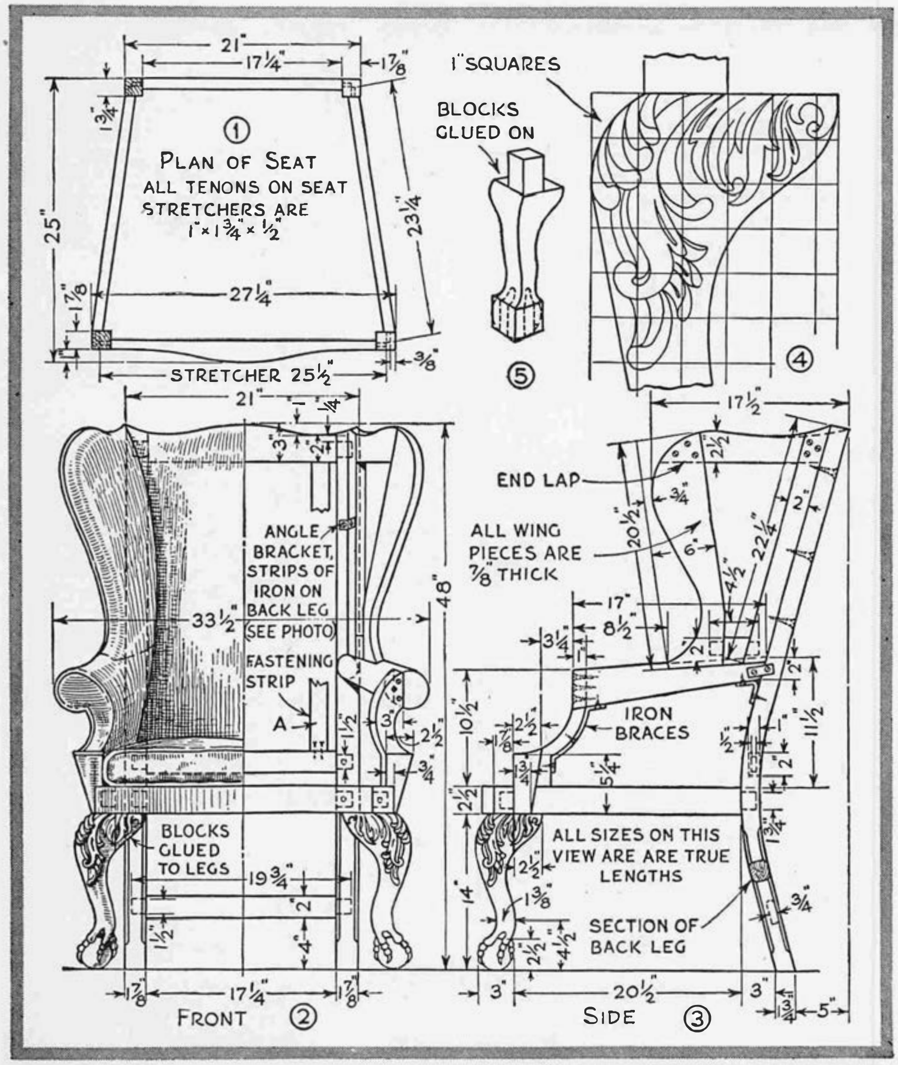
Chippendale Wing Chair

ered with burlap, to which the filling may be sewed.

After the burlap has been tacked in place, the chair is laid on its back and a 5 or 6 in. thick filling of moss is evenly distributed over it. This thickness is considerably reduced when the muslin is stretched over it. Long loops of twine are sewed all over the burlap. When the moss is worked into these loops, they prevent it from sliding about. The moss is first "picked" (pulled apart) to form a springy mass. Not all of the moss need be pulled through the loops—only enough to hold the upper surface of the layer to itself.

The insides of the wings and arms are padded in the same manner, though the filling will vary in thickness from about 1 in., or a little more, around the tops of the arms, to a greater thickness where it is needed. Great care should be taken to keep the filling springy and uniform. The muslin is now stretched over the filling, one surface at a time. The seat should be done last of all. A thin ice pick may be used to shift the moss after the muslin has been stretched, where this is necessary to get the surface smooth. This surface will be considerably improved if a thin layer of cotton felt is placed over the moss before the muslin is stretched over it.

The seat, at the front, has a built-up roll edge, consisting of a roll of tow incased in burlap and tacked to the top of the seat stretcher (Fig. 10). This roll is made fairly hard by sewing a running stitch along its entire length after it has been tacked in place. A piece of upholstering material 7 in. wide must be sewed to the muslin at the front of the seat. This is tacked to the front seat stretcher, along the outside, and to the side stretchers, back as far as the rolls of the arm supports. The tacks holding it will be covered later by the strip of material shown at the lower edge of the seat in the photograph of the finished chair.



Front and side views, plan of seat, one of the foot blocks, and a pattern for the carving. Many parts, being at an angle, are longer than they appear to be, so the true lengths have been marked

No chair can surpass a correctly designed, well-upholstered wing chair in comfort, and it is, at the same time, highly ornamental

The upholstering material—7½ yd. of 38-in. width—used to cover the chair shown was a hand-woven tapestry in an old Colonial coverlet design, known as the "big diamond." A plain material, purchased from a dealer, will serve the purpose, however.

Cover the inside of the wings and arms first. Cut a pattern from heavy wrapping paper, and in cutting the cloth, take considerable care to match the material, so that the figure will go in the right direction and be well balanced. Allow several extra inches of cloth for stretching. The easiest way to cover the wings and arms is to sew a seam directly above the arm, joining the wing cloth to the arm cloth at that place. The writer used only a single piece of cloth for the wing and arm, but this is considerably more difficult to fit. Slip-tack the material to the rear of the back leg; that is, the tacks are not completely driven, which allows them to be removed and the cloth restretched as the fitting progresses. Use 3-oz. tacks and always tack from the center to the ends. The inside wing cloth is drawn around and tacked to the outside of the wings.

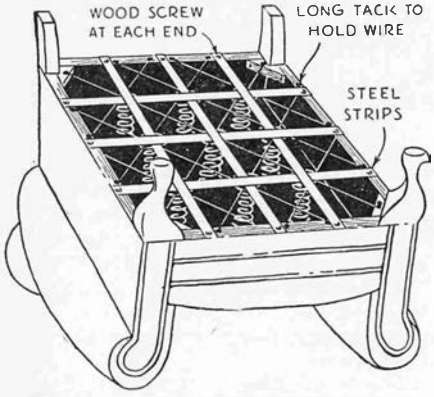
The material covering the arms is tacked to the outside of the seat stretcher at the bottom, after which the webbing may be fastened as mentioned before. At the top it is tacked under the arm roll and sewed to the wing material with a curved upholsterer's needle, using a blind stitch. The cloth for the back (inside) is fastened next. It is tacked to the rear of the vertical strips.

The welt consists of cording of some kind, covered with upholstering material (Fig. 11). A strip of material about

2¼ in. wide will be about right for this purpose, and about 30 ft. will be needed to do the chair and the cushion. The welt is tacked to the very edge on the outside of the wings, to the front of the arms, above the tacking on the material already fastened to the front seat stretcher, and to the rear of the back legs and top of the chair.

The upholstering material may then be cut for the outside of the wings; for the outside of the arms, from the roll down; for the back of the chair; and for the band around the front stretcher. A piece of stiff cardboard is first tacked to the wings on the ouside, after which the material is sewed to the welt with a blind stitch. The material must be turned under at the seam. No cardboard is needed at the back of the chair. The narrow band at the bottom of the front stretcher is blind-tacked; that is, the material is turned forward over the tacks holding it to the seat rail. The bottom of the band is tacked to the bottom of the seat rail. Next sew on the material covering the fronts of the arms, using the blind stitch. Making the cushion then completes the chair.

FLEXIBLE STEEL STRIPS REPLACE OLD WEBBING



The old webbing is replaced with strips of the steel ribbon used to band packing cases

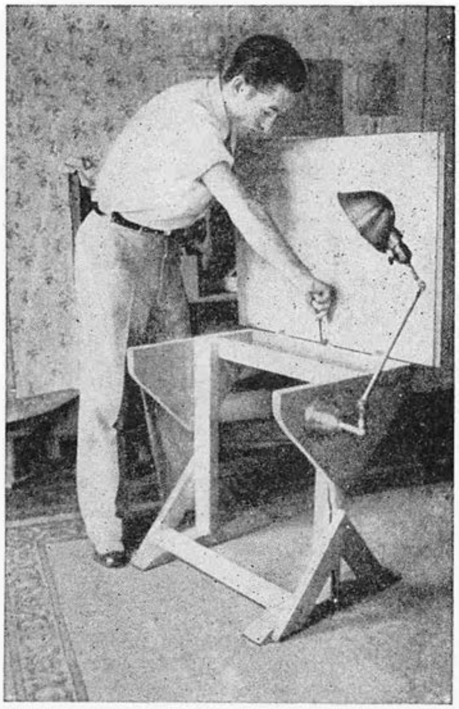
SPRING - UPHOLSTERED furniture often can be permanently repaired by replacing the old webbing with flexible, ribbon steel like that used in banding packing cases. In applying it, proceed exactly as if using the webbing. Fasten the steel strips in interlaced fashion, using a wood screw at each end. The springs should be held out of the way while the steel strips are being fastened so that they will not sag more than desired. After strips are affixed both ways, arrange the springs in their proper places and tie them in position with heavy twine or strong, flexible wire. It has been found that ordinary stranded radio antenna wire suited the purpose excellently. When the job is finished, tack black muslin over the bottom of the furniture.

The steel strips are extremely flexible, yet far stronger than the usual webbing. They may be bought in one continuous strip from hardware dealers or in many cases obtained without cost from the shipping department of some business concern. Usually they come with holes punched about 4 in. apart and may be cut so a hole is in the proper place, at least at one end of each strip. Holes may be reamed larger with the end of a file.

Constructing a Light, Adjustable DRAFTING TABLE

for Home Workshop Use

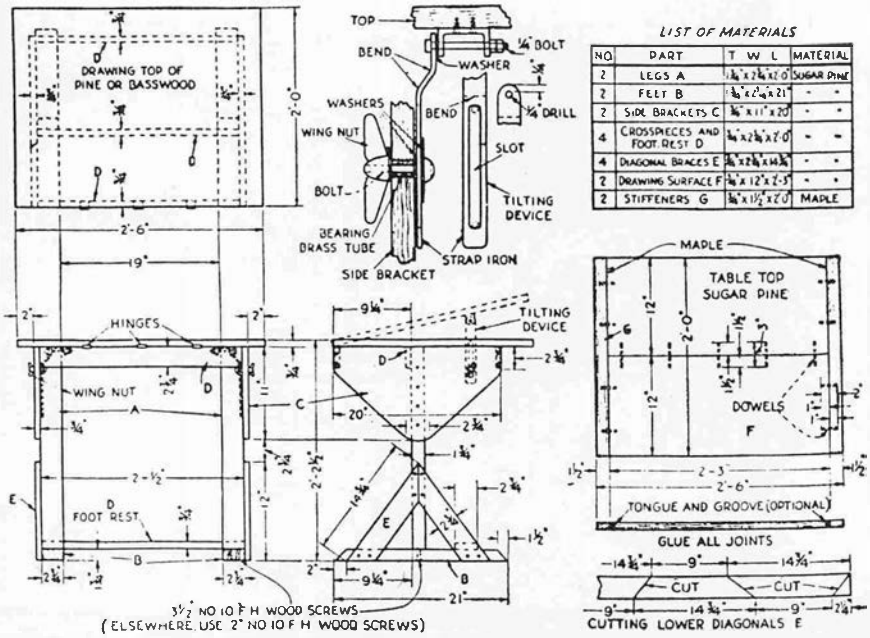
Light as it is, this drafting table is strong, rigid, easily adjusted, and well illuminated



The top is attached to the framework with three brass hinges. Note the lamp bracket

A HANDY all-purpose drafting table is a necessary part of the home craftsman's equipment. The table described here, although extremely light, is rigid and strong and requires a minimum of space.

For the top you may use an ordinary drawing board of pine or basswood, or make one from sugar pine as shown. The stand is also constructed of sugar pine. To assemble the end frames, fasten foot *B* to the leg *A* with 3½-in. No. 10 wood screws and glue. Then select two of the diagonal braces *E* and fasten them as shown in the side elevation. Side bracket *C* should be cut as suggested in the same view unless you desire to mount a cabinet on the stand for supplies; in that case the ends may be left straight. Fasten *C* to leg *A* with glue and four wood screws. Then assemble all with crosspieces *D* and add the foot rest where most comfortable.



LIST OF MATERIALS

NO.	PART	T W L	MATERIAL
2	LEGS A	1¾"x2¾"x2'-0"	SUGAR PINE
2	FEET B	1¾"x2¾"x21"	" "
2	SIDE BRACKETS C	¾"x11"x20"	" "
4	CROSSPIECES AND FOOT REST D	¾"x2¾"x2'-0"	" "
4	DIAGONAL BRACES E	¾"x2¾"x14¾"	" "
2	DRAWING SURFACE F	¾"x12"x2'-5"	" "
2	STIFFENERS G	¾"x1½"x2'-0"	MAPLE

Top, front, and end views, and details of the top, the braces E, and the tilting device

A DAINTY

Dressing Mirror

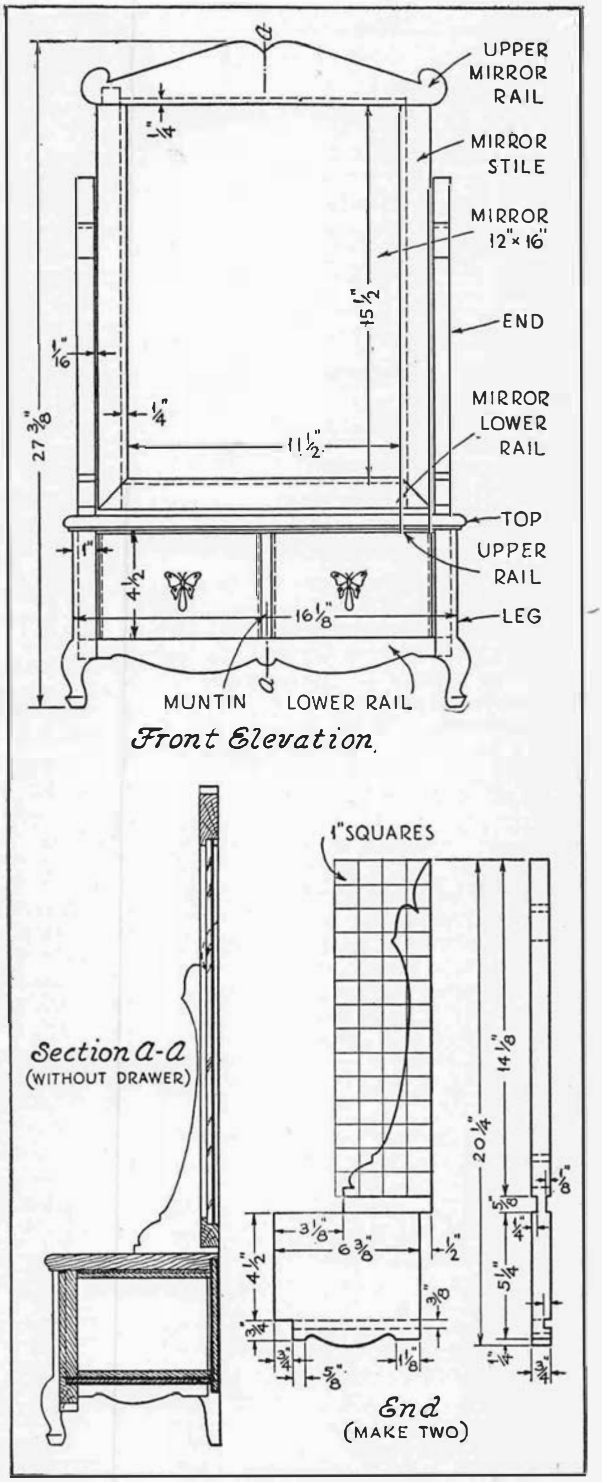
You can learn a lot about fine cabinetmaking by constructing this beautiful little piece . . . and without spending much for materials

PLACED on an end table, a low chest of drawers, or some other piece of furniture, this decorative little dressing glass provides not only a mirror of usable size but also two small drawers for handkerchiefs or gloves. It therefore makes an excellent gift.

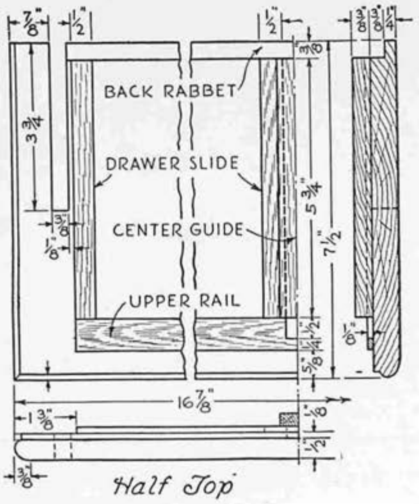
Walnut, mahogany, and maple are desirable for making this piece, but any good cabinet hardwood may be used. The ends are cut from a piece of 1 by 10 in. stock 22 in. long. Shape roughly and joint up the back edges for use as face edges. On one piece square a line across the face side ¼ in. above the lower end. Lay out the ¾ by ¾ in. rail notch in the front edge, and draw the bottom curve, which begins 1⅜ in. from the front edge and ends 1⅝ in. from the back edge. Square another line across the face of the stock 5¼ in. above the first line, and a third, ⅝ in. above the second; these locate the dado for the top of the box. Lay out a similar dado on the opposite side as shown, and a ⅜ by ¼ in. dado on the inner side near the bottom where indicated.

Make a cardboard pattern for the upper end by dividing a 4 by 14½-in. strip into 1-in. squares. On these squares mark the outline intersections and draw smooth curves through the points. Cut out the pattern and trace the outline on the stock. Saw out the profile and cut away the waste material along the lower side of the dado, making a 3⅛-in. offset. Cut the rail notch, rip ½ in. off the back edge up to the dado; then dado the outside ¼ in. deep, and the inside face, ⅛ in. The piece should be well smoothed and sanded. The other end can be traced directly from the first, but must be dadoed so as to make a pair, one right-hand and one left-hand.

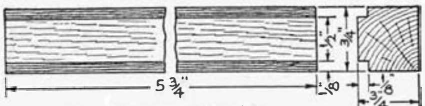
For the top, surface to ⅝-in. thickness a piece of stock 1 by 8 by 17 in.; then square it carefully to 7½ in. by 1 ft. 4 ⅞ in. Make a ⅛ by ⅛-in. rabbet in the underside on the front edge and both ends, and round the edges to an elliptical profile as shown in the detail drawing of the top. On the underside, 1⅛ in. from each end, gauge a line, and gauge another ⅝ in. from the front edge. Rabbet the back edge ⅜ by ⅓ in. to within 1 in. of each end. Make four ⅛ by ½-in. strips 5¾ in. long. Glue these to the top, and nail with brads—one near each end, the outer edge guiding on the the line, and a pair ½ in. apart at the center. Glue a similar strip to butt against the ends of the



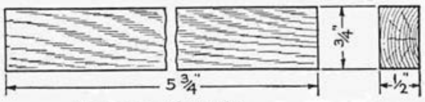
A front view of the assembled dressing mirror, a sectional end view (drawers omitted), and face and edge views of the two ends



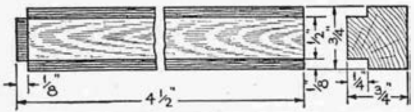
Half Top



Upper Guide



Lower Guide



Muntin

four, guiding on the line parallel to the front edge, and notch out, as detailed, to fit the space between the center strips.

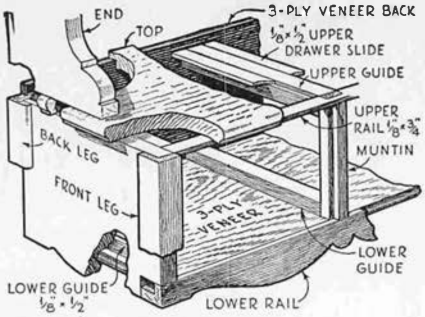
Rabbet a piece ¾ by ¾-in. stock 5¾ in. long as shown for the upper guide, and nail and glue it between the center slides on the top to serve as a center guide for the drawers. Saw notches in the top 3¾ in. long (measured from the back edge) between lines squared ⅞ and 1¼ in. respectively from the ends, as shown in the top detail. This finishes the top.

The muntin is like the upper center guide except that the rabbets are ¼ in. deep, and a tenon ⅛ in. long and ½ in. thick, rising between the rabbets, is made on one end to fit into the notch of the upper rail, already glued to the underside of the top. The total length is 4½ in.

For the lower rail, make a half-pattern on a 1½ by 8-in. strip of cardboard ruled with ½-in. squares, giving the piece a total length of 1 ft. 3⅝ in. Before shaping the lower edge, rabbet the upper edge ⅜ by ½ in.

Make the bottom of ⅜-in. three-ply panel veneer, 6¼ in. by 1 ft. 2⅝ in., and the back, 5½ in. by 1 ft. 2⅞ in.

Assemble the ends and bottom with glue. Slide the top into place in the end dadoes, and toenail 1-in. brads into the underside through the end pieces, where the legs will cover the heads. Put the muntin in place, springing the bottom down sufficiently to clear the tenon, and nail the lower end through the bottom. Then add the lower rail, gluing all joints and nailing the front edge of the bottom into its rail rabbet with ¾-in. brads. Put a ½ by ¾-in. lower center guide on the bottom, applying it as shown in the broken-away perspective drawing of the case.



Perspective showing method of construction. The other drawings give dimensions of parts

The two front legs are made of stock 1½ in. square and 7¼ in. long. For a length of 5¼ in., rabbet each ¾ by ¾ in.; then lay out and cut the curved parts from a pattern made on a piece of cardboard with squares. The side pattern, when bent around the shaped curve, gives a true profile for cutting the other sides. Carve out the curved surfaces until they blend smoothly into the straight parts, round off the two rabbet corners as shown, and glue the legs to the box.

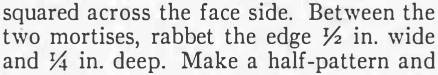
The back legs are profiled in only one direction, the front faces being curved back to give the necessary thinness. The back face of each is rabbeted ½ by ¾ by 5¼ in. to fit over the back edge of the end pieces, and has a ⅜ by ⅜-in. rabbet to receive the end of the back.

For the upper mirror rail, cut a piece of 1 by 3 by 16-in. stock and make a mortise ¼ by ¾ by ¾ in., centering on the face edge and 6 in. from a center line squared across the face side. Between the two mortises, rabbet the edge ½ in. wide and ¼ in. deep. Make a half-pattern and shape the upper edge in the way shown.

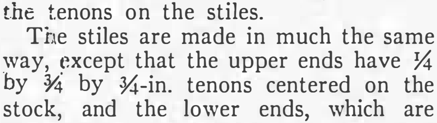
The lower rail is ¾ by 1¼ in. by 1 ft. 2 in., rabbeted full length on one edge. Miter both ends as shown, and notch them ¼ in. wide and 1 in. deep, to receive the tenons on the stiles.

The stiles are made in much the same way, except that the upper ends have ¼ by ¾ by ¾-in. tenons centered on the stock, and the lower ends, which are mitered, have triangular tenons that mate with the lower rail. The total length is 1 ft. 5½ in.

After trying the parts to see that they fit, assemble the rails and stiles and reenforce the joints by driving brads into them from the backs. Round off the inner corners of the frame to a radius of ¼ in. Slip the mirror into the rabbet from behind, cover the back with cardboard, and secure it with a ¼ by ¼-in. molding nailed inside the rabbet. Hang the mirror on the end supports with pivots screwed to the back.



Half Lower Rail



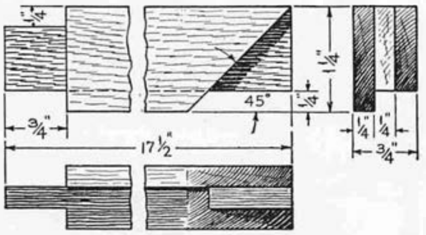
Half Upper Mirror Rail

Make the drawers carefully to fit. The front should be made of ½-in. stock, and it will be about 4⅜ by 6 13/16 in. It is rabbeted 13/32 by 5/16 in. at each end to take the ¼-in. thick sides and leave the necessary overhang. It is also grooved ¼ by ¼ in. inside at a distance of ¼ in. from the lower edge to take the bottom. The sides are ¼ by 4⅜ by 6 3/16 in., grooved ¼ by ⅛ in. for the bottom and rabbeted on the back ends ⅛ by ¼ in. for the back. The back is ¼ by 4 by 6¼ in., and the bottom ¼ by 6¼ by 6⅛ in. Verify all dimensions from the assembled cabinet.

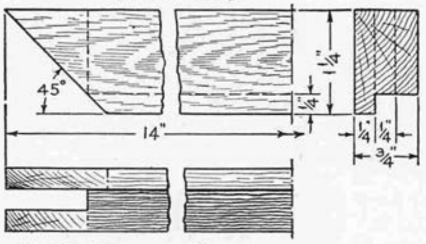
In assembling the drawers, nail the sides to the front rabbets with 1-in. brads, and the back to the side rabbets with ¾-in. brads. Slip the bottoms into the grooves, square up, and nail the bottoms. So made, the drawers should have a side and a back clearance of about 1/16 in.

To correspond with the tops on the muntin, glue ⅛ by ½-in. stops against the end pieces of the cabinet, and glue similar pieces horizontally as side guides, both at top and bottom. Slip the drawers in place, note the fit of the fronts, and make necessary corrections. By working accurately and beveling slightly the edges and ends of the front, the joint can be made very narrow without the drawer's binding. Note that the fronts slide 1/16 in. behind the rail and muntin faces.

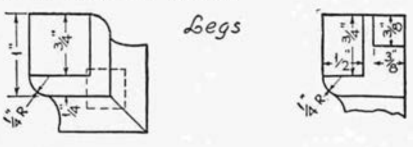
Sandpaper the wood to glasslike smoothness, finish as desired, line the drawers with velvet, and put on the drawer pulls.

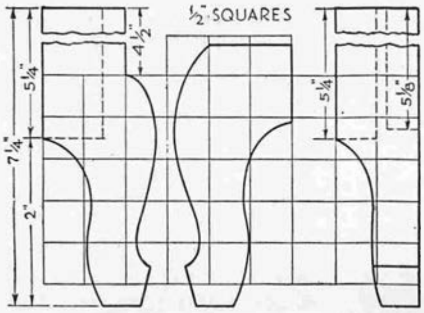


Mirror Stile
(MAKE TWO)



Half Lower Rail





PANELS OF GLEAMING BRASS SET OFF THIS

Decorative Wastebasket

A design that will show your skill without costing much for materials

In style, novelty, and workmanship, this wastebasket is far superior to ordinary designs, made for use rather than beauty. The plans appear at right

IT IS usually difficult to purchase a correctly styled basket for waste paper. That this article of furniture should fit in with the general scheme of room decoration is a matter which seems to be given little thought. The Colonial design illustrated above lifts this neglected article into a class with other well-designed pieces, and makes it a thing of beauty as well as use.

Select a wood in harmony with the Colonial design, such as walnut or cherry. If these woods are difficult to obtain, others may be used and stained and finished to imitate them. Both red gum and mahogany take a good walnut stain. Oak, too, may be used and stained brown, but it is less desirable for Colonial type furniture.

Work out the four uprights first; these are 1⅛ in. square and 16¼ in. long. After squaring up this stock, cut it to about 17 in. long to provide waste stock at the ends for turning. As will be seen in detail drawing *D*, the base turning is larger than the rest of the upright. In order to make this turning, extra stock will have to be glued to each upright as shown at *G*. Care should be taken to produce a good, sharp, accurate piece of turning.

The next step is to make the side rails, which are fastened with mortise and tenon joints, as in the assembly drawing *B*. To simplify the work a little, ⅜-in. dowel fastenings may be used instead; however, the mortise and tenon joint makes the best fastening and is more truly Colonial. It certainly should be used if one has machine tools.

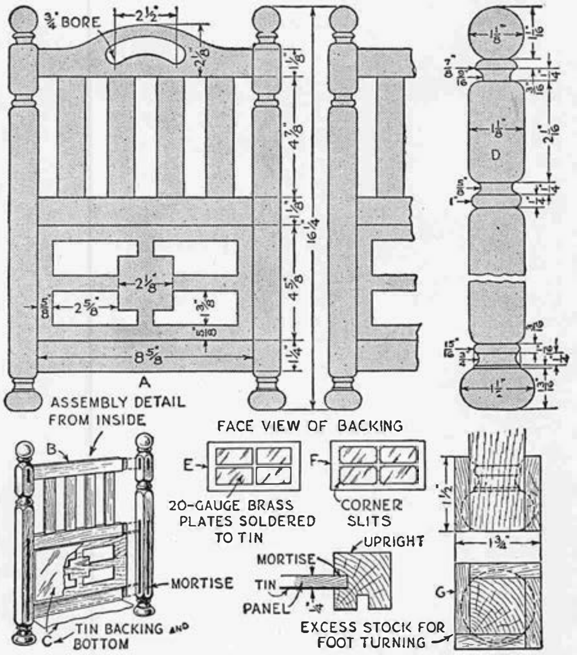
Two of the upper side rails are shaped into handles as shown at *A*. The boring should, of course, be done from both sides to avoid splitting.

The two bottom rails are grooved to receive the panels, as are also the uprights.

The panels, as shown at *E*, are made of ¼-in. stock backed by a sheet of tin. Four small pieces of 20-gauge brass are soldered to a tin backing sheet in such a way as to show through the openings in the panels. If it is not convenient to solder these pieces of brass to the tin, they may be attached as shown at *F*. The brass is polished with a piece of fine sandpaper or with fine steel wool and given a coat of clear lacquer to prevent tarnishing. This is done before the work is assembled.

The design for cutting out the wood panels is only a suggestion; any other suitable pattern may be used, provided it is in harmony with Colonial design.

The bottom is a piece of sheet tin, tacked in place with ⅝-in. No. 14 brass escutcheon pins as shown at *C*. After the piece is assembled, the tin back of the panels and the bottom are painted with dull black paint.

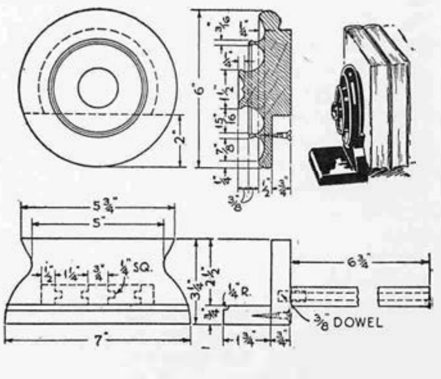


The finished piece is stained with walnut oil stain and given a thin wash coat of shellac. This is ordinary shellac thinned with four parts alcohol. After this it should be given an oil finish. Early cabinetmakers produced this finish by applications of raw linseed oil. The oil is applied frequently during a period of a number of days; and each application is allowed to dry about one hour and then thoroughly rubbed off. This eventually makes the most beautiful and durable finish that can be applied to wood. If this finish is not used, however, the piece may be varnished and given a rubbed finish with pumice stone. In no case should the finish be brought to a high polish. Newness is to be avoided. Try to give the work an appearance of age.

TURNED ROSETTES SERVE AS BOOK ENDS

LARGE rosettes, turned on the lathe, form the end blocks of the adjustable book rack illustrated in the drawings at the right. The rack itself is of a familiar type, with a bottom made of tongued-and-grooved members so that the ends may be moved in or out to suit the number and thickness of the books. Metal strips hold the ends of the slides from spreading and serve as stops.

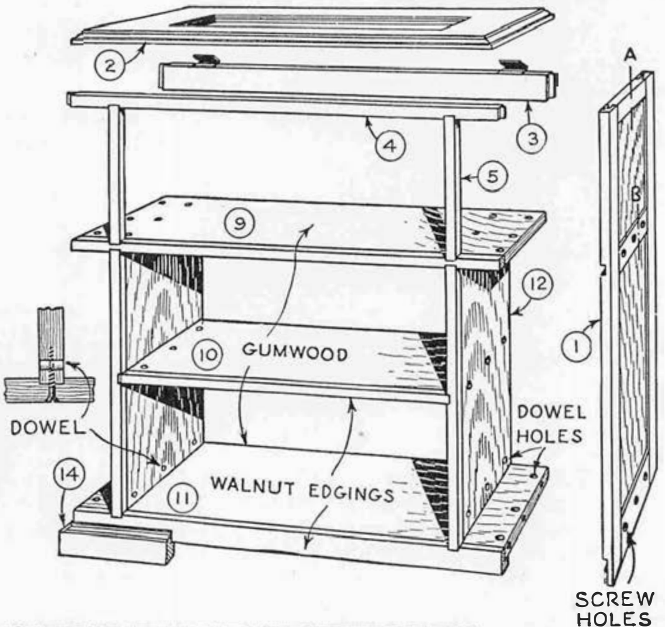
The rosettes, after being turned to the design shown or to any other that appeals to the craftsman, are cut out as shown to fit over the end pieces and are attached with glue and screws driven from the inside. The original book ends were made of walnut and faced inside with velvet.

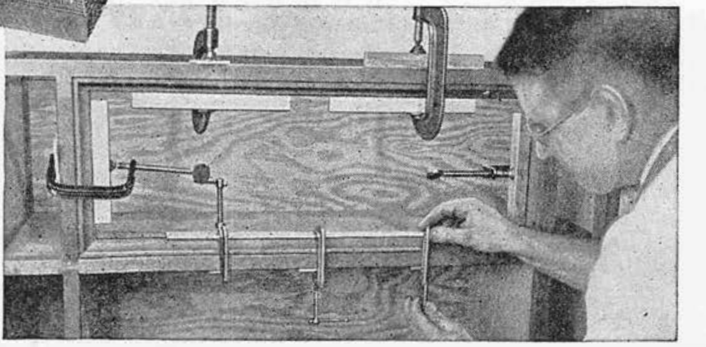


I*lluminated* Aquarium

SET IN BOOKCASE

The aquarium is lighted from the ends by two lamps set behind panels of frosted glass, which bear paintings





General method of assembly, one way to make the sides, and frame for the lid. The latter, however, may be made solid

At left: Gluing and clamping the molding around the front opening of the aquarium holder. *Below:* Completed piece

THIS combination aquarium-bookcase forms a beautiful setting for goldfish or tropical fish. The tank—never a particularly sightly object—is so framed that it is practically hidden. When the lights are lit at night, the colorful little fish are seen in a gorgeous, ever-changing pageant. Decorative transparent panels at each end heighten the unique and brilliant effect.

Even in daylight the fish are displayed to advantage. The aquarium should be placed in the usual position before a window, just as if it were an ordinary tank, and the light then shines through and illuminates the whole upper compartment.

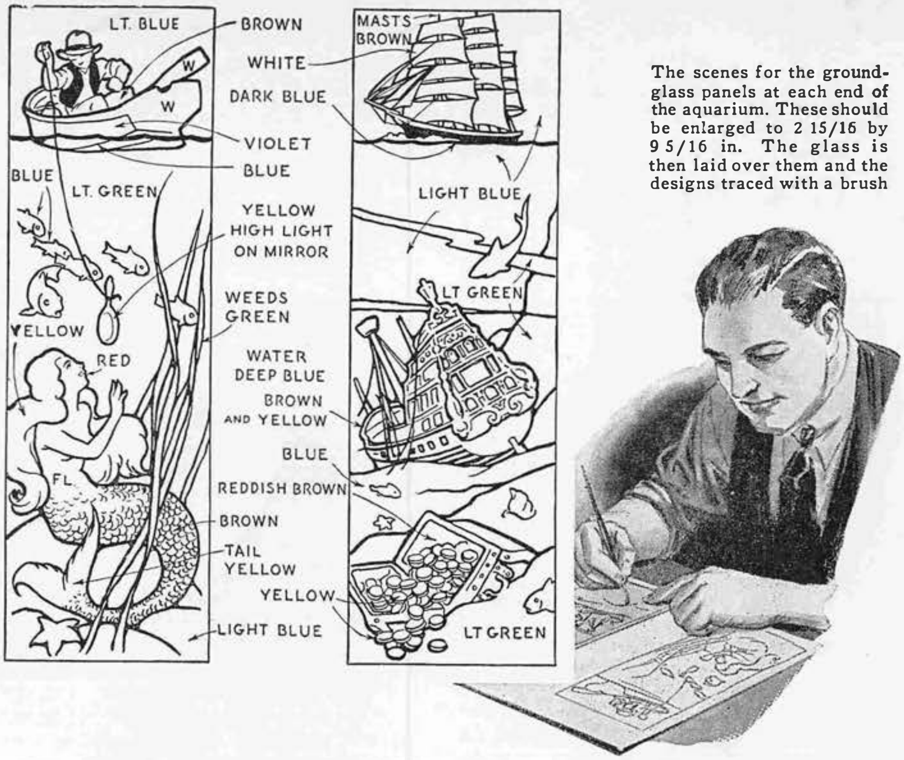
The tank is set on the upper shelf *9* and covered by the hinged lid *2*. This lid was originally made with a plate glass panel over the tank, but was later changed to a solid wood panel, as it was found that objectionable condensation occurred on the glass panel when the house cooled off at night. The glass panel is preferable in appearance; and if the aquarium bookcase stands where the temperature does not vary more than a few degrees, the condensation would be negligible.

At each end of the aquarium is placed a small electric light. In front of each is a panel of frosted glass having an underwater scene painted on it in oil colors. The lights are connected in parallel and provided with an extension cord long enough to plug into the nearest outlet. A switch on the back panel of the bookcase enables you to turn off the lights without pulling out the plug. Back panel *15* extends up only to the shelf *9*, leaving the back open to the light in the daytime. This is necessary for the health of the fish, and it also shows off the paintings in daylight.

The dimensions may be altered to accommodate any long, narrow tank. You may use one on hand, buy one ready-made, or build one yourself. Drawings that are included herewith show how the ¾ by ¾ by ⅛ in. steel angles used in making this tank were joined at each corner. If the separate pieces are cut to size before taking them to a welding shop, you may get the welding done for a small charge. Test the tank for leakage for several days before installing it in the bookcase.

For convenience in describing the construction, it is assumed that walnut is to be used, although any suitable cabinet wood, of course, may be substituted. The work may be reduced at some sacrifice of appearance by making ends 1 and lid 2 of solid walnut or of 13/16-in. thick walnut plywood, instead of paneled. If plywood is used, the front edge of ends *1* should be covered with walnut about ⅛-in. thick, glued on to conceal the core. Also, if the lid is made of one piece of plywood, it may be dressed to a size of 12 by 33¾ in., and strips of solid walnut ¾ in. wide may be mitered at the corners and glued

Unique New Piece of Furniture Is Beautiful Setting for Tropical Fish



The scenes for the ground-glass panels at each end of the aquarium. These should be enlarged to 2 15/16 by 9 5/16 in. The glass is then laid over them and the designs traced with a brush

on each edge to build it up to the required size and to provide stock for molding the edge.

If it is decided to build up ends *1* as panels in the way shown, the machining of the composite parts of the panels may be done very simply by using the dado head set to cut a ¼ in. wide groove. This groove is run entirely along one edge each of the side, top, and bottom rails and along both edges of the middle rail, ¼ in. from the face side. The cross rails have ¼ in. thick tenons on each end that fit in the same groove in the side rails in which the ¼-in. three-ply walnut panels are inserted. The projecting panel molding is fitted and glued in place after the bookcase has been completely assembled.

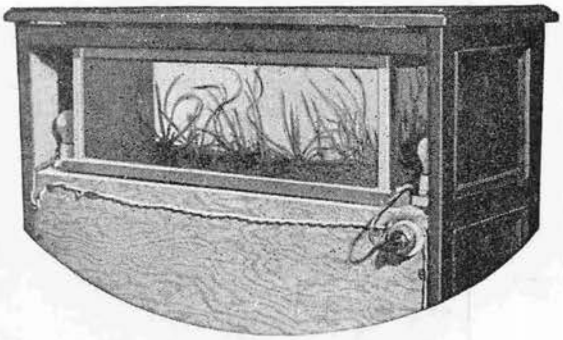
The front edges of the shelves and partitions, which can be made of gum or clear pine, are edged with about ¾ in. of walnut. The lower shelf, marked part *11*, has a 1 13/16 by 13/16 in. walnut front piece, which is rabbeted out and glued on the main part of the shelf. This is put on before the piece is trimmed to finished dimensions. Section *B*, near the end of the article, shows the method of fastening the case together. The ½-in. dowels should first be glued in the proper places to take the screws, and the projecting ends carefully trimmed off flush.

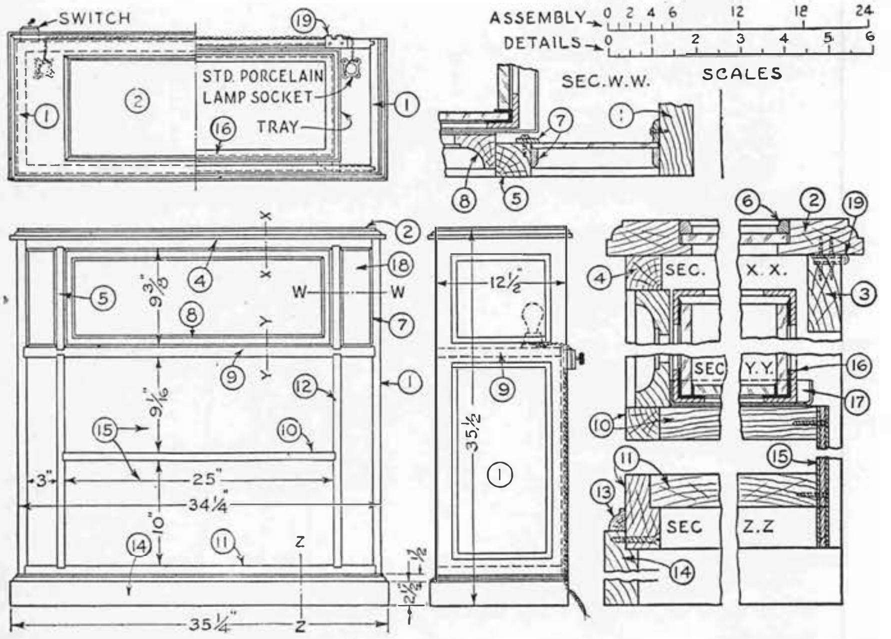
Now the 3/16 by 13/16 in. grooves should be cut in their proper locations on parts *1*, *4*, *9*, *10*, *11*, and *12*. This may be done efficiently with the aid of the dado head on the saw table, or by using the circular saw itself, taking several cuts for each groove. At this time also cut the ¼-in. grooves in end panels *1* to take back *15*, and the grooves or mortises at the top to take top rails *3* and *4*. Drill and countersink the clearance holes for the 1½-in. No. 8 flathead screws. The screw holes in ends *1* should be counterbored ½ in. in diameter and about ⅜ in. deep for wooden plugs.

The assembling is done in the following order: the vertical partitions *12* are screwed to middle shelf *10*; upper shelf *9* and lower shelf *11* are screwed to partitions *12*; then side panels *1* are screwed to shelves *9* and *11*. Make a trial assembly first without glue. When the final glued-up assembling is done, have someone help you so that the work may be completed before the glue in the first joint has had time to set. Glue in place the concealing plugs over the screws in the ends, making sure the grain in the plugs runs in the same direction as in the surrounding wood. Then, at your convenience, glue in place top rails *3* and *4* and vertical posts 5. These last may be bradded in place in addition to being glued.

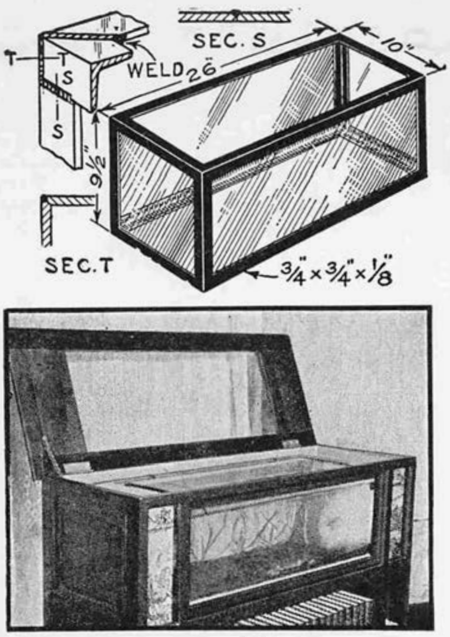
Trim off all the flush joints and clean off the excess glue by careful use of a sharp chisel

The back of the aquarium compartment is left open so that when it is set before a window, light shines through





The general construction. Sizes of all parts are given in the list of materials, but detailed dimensions have been omitted because most builders will wish to make modifications

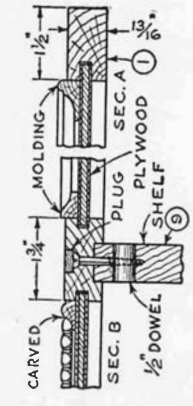


A suggestion for making a tank and how it appears in the case with the lid turned up

and fine sandpaper. Do all the final finishing work possible, such as scraping and sanding, on the case before the moldings are applied. Fit base 14, which is mitered at the corners, and assemble with glue and screws. Molding 8 should be fitted very snugly and may be simply glued and clamped in place, as shown in one of the photographs. Add the molding at the base and the panel molding, if used; these can be secured with glue and countersunk brads. Fit the lid hinges and the sliding lid support to hold it open. Fit back panel 15, slide it into place from the bottom, and secure it with a few screws into the shelves and partitions.

The interior of the top compartment housing the aquarium may now be painted or lacquered a light gray or cream color. The outside may be stained and finished as desired, although a two-coat spar-varnish finish is recommended.

The end panels are of ground glass with the decorations painted on the rough side. Small pieces of the size required, 2 15/16 by 9 5/16 in., are really scrap sizes, and may often be obtained for little or nothing. Obtain some extra pieces to practice on. Lay out the design carefully full size by the square method or by pantagraph; or better yet, by having a photostatic or photographic enlargement made of the drawings. Lay the glass over the enlargement, ground side up, and lay in the black lines with a rather thick paint made by mixing lampblack ground in oil with a little spar varnish. A very fine camel's-hair striping brush is satisfactory for laying in the broad sweeping lines. The smaller details are put in with an ordinary writing pen. You may find it easier, in fact, to do all of the lining in with the pen.

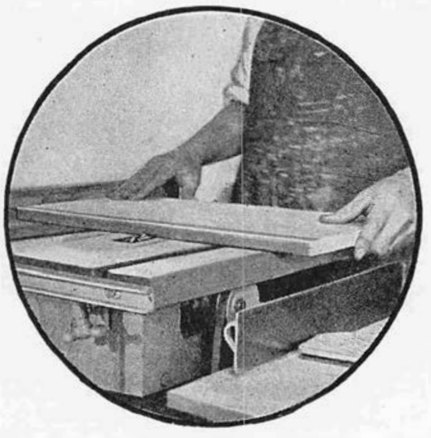


Section through the upper part of a side panel

Allow the black lines to dry twenty-four hours or more before doing the tinting. The colors used, in addition to black, are cobalt blue, chrome green, burnt sienna, yellow, and red. The best way to obtain them is in small tubes ground in oil. Mix with spar varnish and thin with turpentine. Use a medium sized camel's-hair artist's brush for applying them to the glass.

Do not have the colors too thick, as they must show up by transmitted light. The effect should be observed from time to time as the coloring is being done by holding the glass up before an electric light. If too much color is put on, it may be removed by brushing gently with a brush dipped in clear turpentine and soaking up with a clean cotton rag. The finished glass panels are held in place by lengths of molding 7, screwed in place from the rear.

A metal pan made of thin aluminum, zinc, or copper should be put under the aquarium to safeguard against small leaks that might develop. After the aquarium-bookcase is in its final location, the tank may be put in place and filled. The wiring and switch is then installed and the porcelain socket receptacles screwed down in such positions that the lights illuminate both the fish and the glass panels.



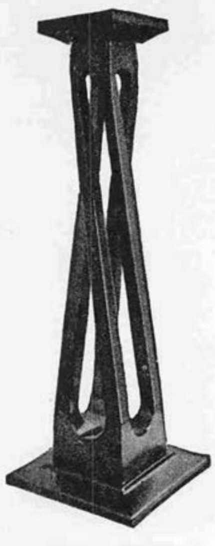
While a dado head facilitates the work, the grooves can be made with successive saw cuts

List of Materials

Part No.	Name	No. Req.	Description
1	End panel	2	13/16 x 12½ x 32 11/16 over all
2	Lid	1	13/16x13½x35¼ over all
3	Top rear rail	1	13/16 x 1¾ x 33⅜
4	Top front rail	1	13/16 x 13/16 x 33⅜
5	Post	2	13/16 x 13/16 x 9¼
6	Lid glass molding	4	2—25 in.,2—10 in.
7	Painted panel molding	12	4—3¼ in., 4—9¾ in., 4—9⅜ in.
8	Aquarium molding	4	2—9¼in.,2—26in.
9	Upper shelf	1	13/16 x 12 x 33
10	Middle shelf	1	13/16 x 12 x 25⅜
11	Lower shelf	1	12 x 33 in. long
12	Partition	2	13/16 x 12 x 20¼
13	Base molding	3	2—14 in., 1—36 in.
14	Base	3	13/16 x 2½, 1—36 in., 2—14 in.
15	Back	1	¼-in. fir 3-ply, 33⅛ by 21½
16	Aquarium frame	1	10 x 9½ x 26 in. over all, made of ¾ by ⅛ in.steel angles
17	Tray	1	10½ x 27 x ⅝ in. deep
18	Ground-glass panels	2	2 15/16 by 9 5/16
19	Butt hinges	1 pr.	1½ x 2
20	Sliding lid support	1 pr.	

TWISTED FLOWER STAND CUT FROM SOLID WOOD

THIS unusual wooden flower stand is certain to arouse curiosity wherever displayed. At first sight, it looks as if it had been twisted bodily a quarter of a turn by the hands of some giant. Actually the pedestal is shaped from a solid block of wood 4 by 4 by 18 in.

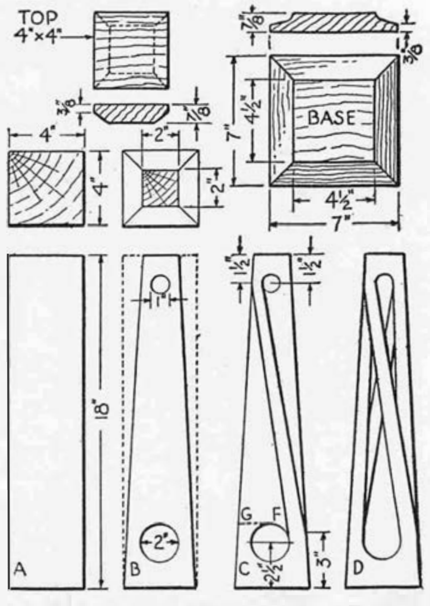


A giant might have twisted this stand

Plane the sides of the block square, and see that the two ends also are exactly square as shown at *A*. Then taper the block to 2 in. square at one end, as at *B*. Now bore a 1-in. hole 1½ in. from the top and a 2-in. hole 2½ in. from the bottom and in the center of all four sides. Bore each hole only halfway through. Mark the four sides as at *C* and cut away the triangles based upon the dotted line *GF*. Some of the inside wood can be cut away with a compass saw, but the rest must be carved out with chisel and pen-knife to obtain the final shape, which is shown at *D* and in the photograph.

The top is ⅞ by 4 by 4 in. with the bottom edges beveled back ¾ in. Dowel and glue the top on. The base is ⅞ by 7 by 7 in., the edges being shaped as shown in the drawing. It is fastened to the body with screws.

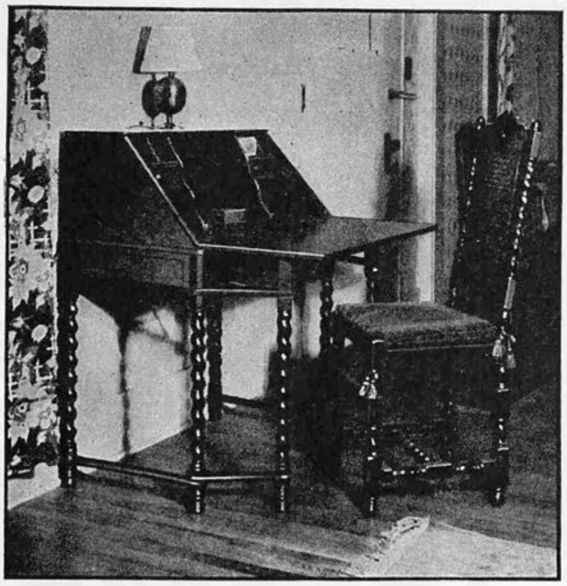
The stand illustrated was made of cypress and stained a walnut color. It was then given three coats of shellac and rubbed down well between coats with fine sandpaper and steel wool.



The four steps in laying out and carving the pedestal, and details of top and base blocks

EASILY MADE SPIRAL LEGS ORNAMENT THIS

Slant-Top Walnut Desk



HERE is a slant-top, gate-leg desk that is not only unusually attractive in itself, but also offers the amateur woodworker practice in a variety of interesting tool processes, including spiral turning. Not that you need much equipment to make it. The original model was built entirely by hand, but if you own power tools, you can use them to advantage. A lathe is useful, of course, for rough turning the legs to a cylindrical shape, although even this work can be done with plane, rasp, file, and sandpaper. The spirals themselves have to be made by hand, and the tools required are only a wood rasp of half-round shape, a large bastard-cut flat file, and plenty of sandpaper.

The original desk was built to match the spiral-turned chair shown with it in the photograph above. An unusual feature is the use of gate legs in front. These are arranged so as to support the hinged desk board when it is in the writing position. Well-seasoned walnut is the best wood to use in making this desk.

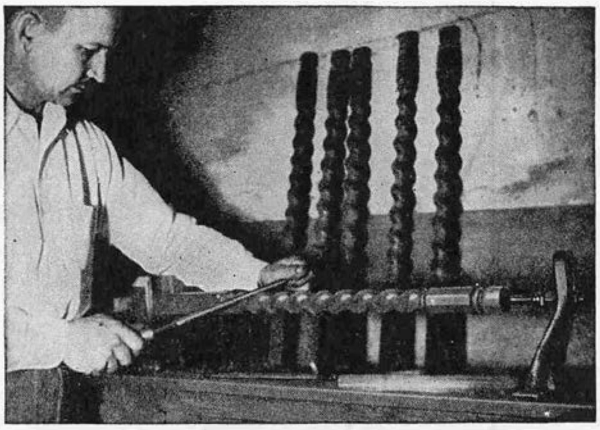
The legs were made from pieces that dressed 1¾ in. square (Fig. 1). They may be turned in one piece or made in sections, as preferred. If the legs are turned in sections as in Fig. 1, the bearings can be made without splitting the ends of the stretchers. If they are turned full length, the stretcher bearings must be split as at *b*, Fig. 4, then glued together around the bearing surface.

Before shaping the spirals, place each leg in a lathe and turn to 1¾ in. in diameter all portions of the leg that are to be spiral or round. Turn a ⅜-in. bead near the top and two near the bottom as shown. Turn the foot of each leg, and turn to ¾ in. in diameter all dowel parts. Bore holes for these in the shorter sections of the legs if you make the legs in sections.

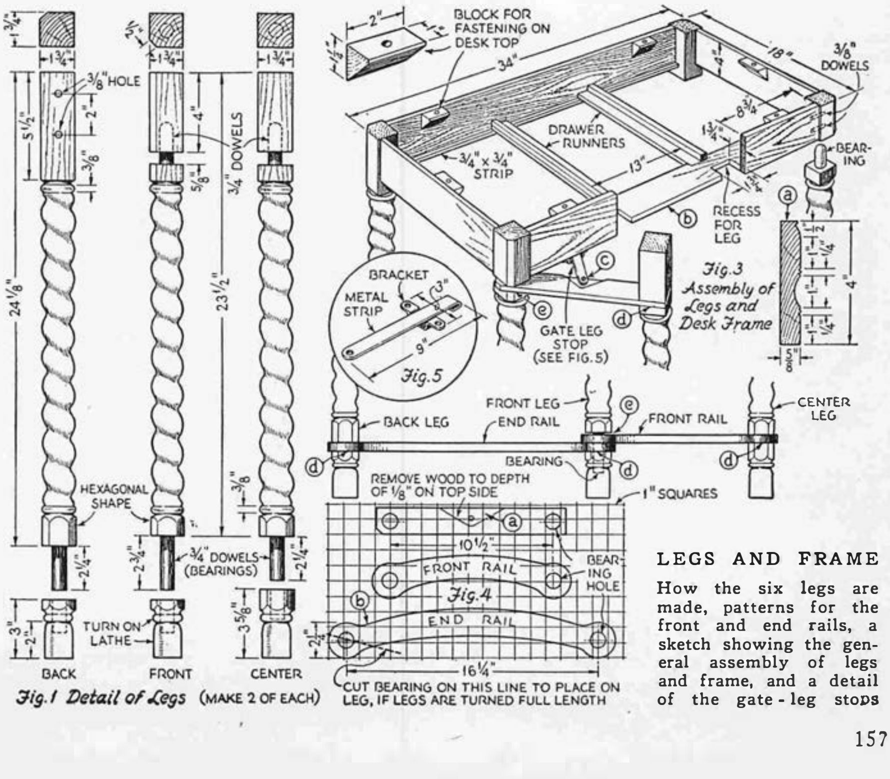
Wrap a 1½-in. wide strip of paper spirally around each portion to be made into a spiral, leaving enough space between the edges of the strip to mark the spiral with a pencil. Then saw a ¼-in. deep groove throughout the length of the spiral mark. With the edge of the wood rasp, widen this saw cut into a V-notch. Use the round side of the rasp to work this notch into a rounded spiral depression. This forms the inside curve of the spiral turning. With the flat side of the rasp, turn off the shoulders to form the outside curve of the spiral. You need not be too particular as the sandpapering will remove all inequalities.

To bring the curve to true proportions, use ½-in. wide strips of sandpaper as shown in one of the photos. The best sandpaper for this is the tough-backed paper used in sanding belts. Start with a coarse grade, but finish with a finer grade. Then use a fine grade of sandpaper in the palm of the hand while turning the spiral in the palm with your other hand.

Figure 3 shows the general method of assembling the legs and desk frame. The front and end members are 4 in. wide, and the back member is 4¾ in. These may be plain or molded on the shaper or with combination plane or gouges, as shown in the cross section *a*. The cross members are fitted to the legs with ⅜-in. dowels, two in each end. The front cross member does not extend entirely across the desk,

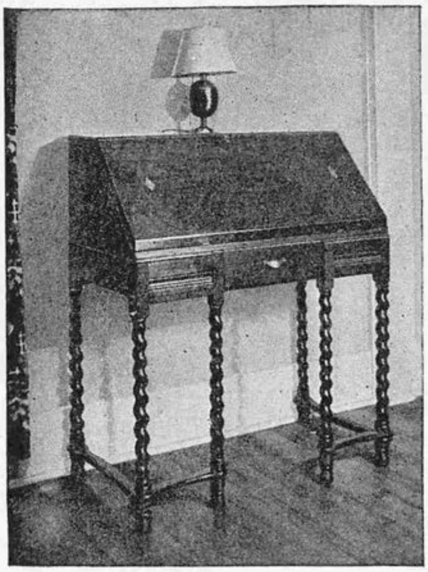


After the spirals have been marked on the turned legs, they are cut in with a saw and widened to the right shape with rasp and file



LEGS AND FRAME

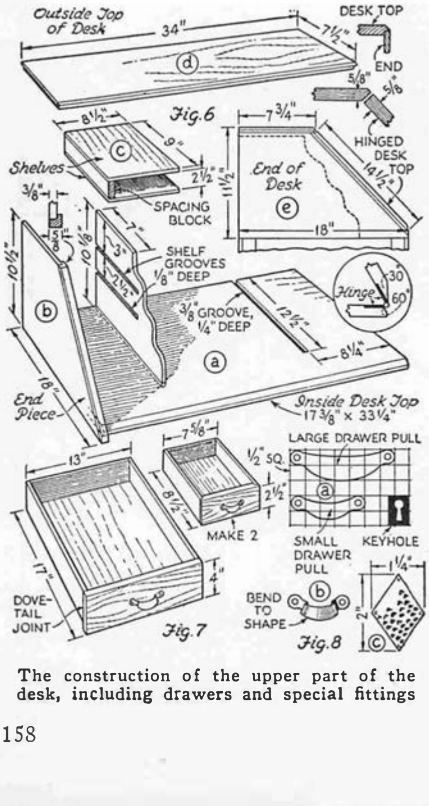
How the six legs are made, patterns for the front and end rails, a sketch showing the general assembly of legs and frame, and a detail of the gate-leg stops



The desk with the top and gate legs closed

space being left for the gate-leg recess and a drawer. A piece of 1 by 4-in. material fitted to the front cross members at right angles as shown at *b*, Fig. 3, provides support for the drawer runners and the cross members. A ¾ by ¾-in. strip glued to the bottom edge of the back cross member supports the back ends of the drawer runners. The drawer runners are fitted at the front ends by lap joints. Recesses are cut as shown for the swinging gate legs.

Dimensions for the front and end rails are shown in Fig. 4. These are made of ⅝-in. walnut. Holes ⅞ in. in diameter are bored in the ends for fitting on the legs. The top front rails are left square cornered to fit flush with the front of the desk, but the lower rails are much more attractive if the edges are rounded with a shaper or worked off across the edge with a file or strips of sandpaper. A triangular recess ⅛-in. deep is cut in the top of the upper rail at *a*, Fig. 4 for fitting the end of the gate-leg stop, which is shown at *c*, Fig. 3.

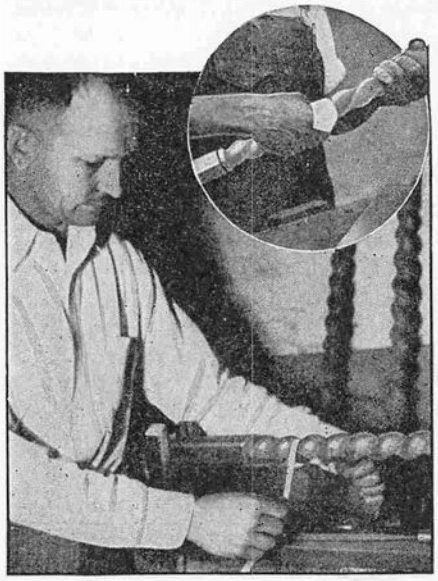


The construction of the upper part of the desk, including drawers and special fittings

Before assembling the rails and the legs. paint the two bearings on the outside front legs, both inside the rail bearing and on the leg dowel, with hot paraffin. Glue the joints marked *d*, Fig. 3, tight, but leave about 1/32-in. space at *e* so the bearings will not bind. Use a good grade of glue.

Figure 5 shows a ⅛-in. strap iron bent over at the end and a keeper for limiting the swing of the gate-leg front. Mount these as at *c*, Fig. 3.

The desk top is shown in Fig. 6. It was cut from a glued-up piece of walnut to the dimensions shown at *a*. A 60-deg. bevel was cut on the front edge, and two 12½-in. long grooves were cut for the lower edge of the dividing walls of the desk. The ends of the desk were built of ⅜-in. veneered stock as shown at *b*. A ⅝-in. strip was rabbeted and glued to the front edge to give added strength. However, this entire piece may be made of ⅝-in. material, if desired. In that case it will be unnecessary to use the spacing block shown at *c* to set the drawer over to miss the edging strip. Shelves and inside dividing walls were made of ⅜-in. wood as shown at *c*, and the outside top of the desk is given at *d*. The cross sections and view at *e* show in detail the fitting of the top and the desk board.



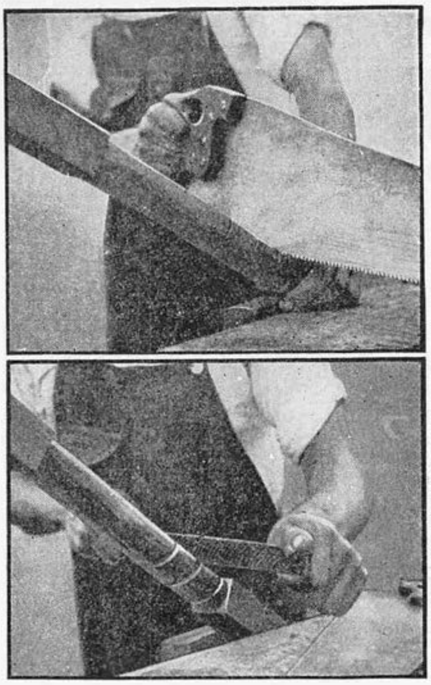
The finishing is done with narrow strips of tough-backed sandpaper, followed by a rubbing with fine sandpaper as shown in the circle

Figure 7 illustrates the construction of the drawers. The larger drawer was made with dovetail joints, and the two smaller inside drawers with simple rabbeted joints.

Hand-hammered lacquered copper hardware was used. Dimensions for the drawer pulls are shown at *a*, Fig. 8. These blanks were cut from heavy copper and hammered to the shape shown at *b*. Two diamond-shaped bumpers were cut and hammered from copper as at *c*. These were nailed to the desk board with copper nails so they rest on the top of the two gate legs when the desk is open and prevent marring the desk board.

GASOLINE CLEANS SHOE BRUSH

When the family shoe brush is so full of wax polish that it will no longer shine shoes, it may be cleaned by soaking it in gasoline and spraying it with a hose.



The upper view shows the process of sawing the spiral lines ¼ in. deep; the other photo, the first step in rasping out the grooves

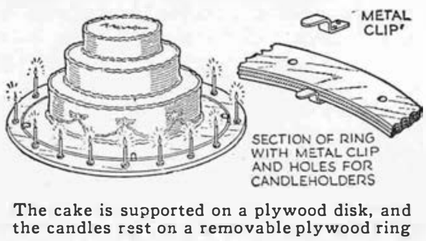
After the candles have burned down, the ring is lifted entirely away to enable the cake to be cut

BIRTHDAY CANDLES HELD ON RING AROUND CAKE

HARDLY a birthday party ends without a burned or greased tablecloth. Here is a contrivance that removes this danger.

Cut from ½-in. plywood an 18-in. disk. Now saw from the disk a 1-in. ring. The edge of the remaining disk should be trimmed to give from ⅛ to 3/16-in. clearance between disk and ring. Bend four small pieces of metal to form projections that will hold the ring a trifle higher than the upper surface of the disk, and nail them lightly to the underside.

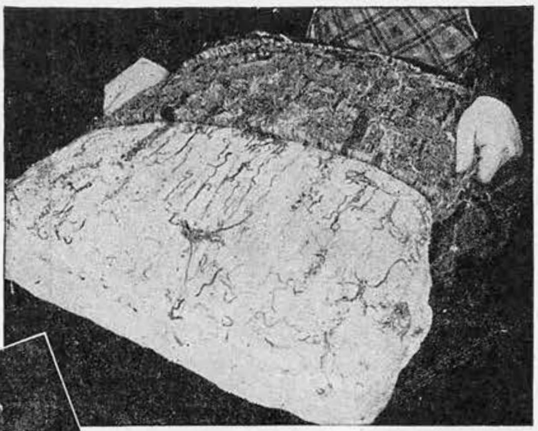
The cake is placed on the disk, and the ring with candles in place is dropped into place. After the candles have burned down a bit, the ring with its smoking and dripping candles can be lifted clear and carried out bodily to the kitchen.



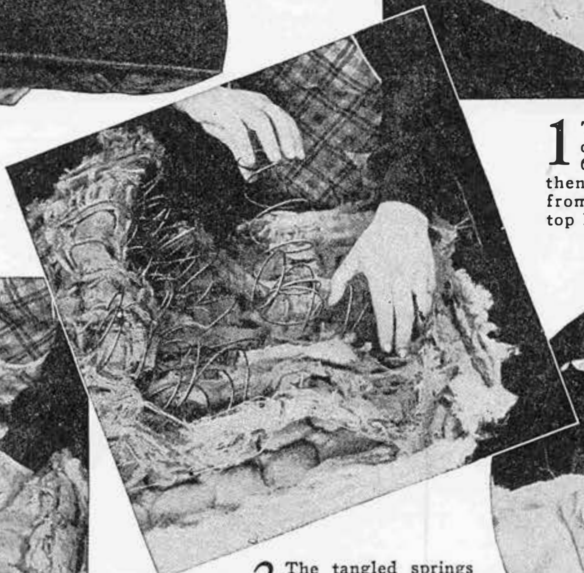
The cake is supported on a plywood disk, and the candles rest on a removable plywood ring

REPAIRING
Overstuffed Cushions

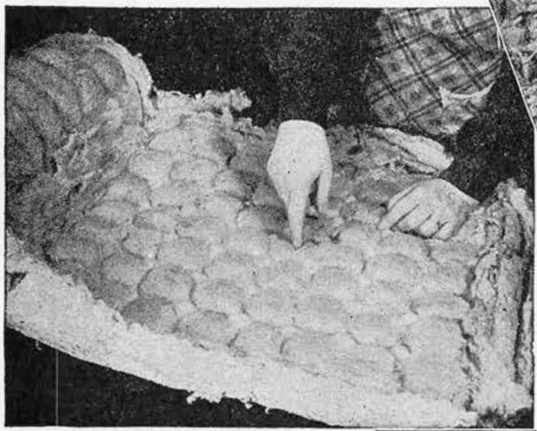
Overstuffed cushions, on the verge of breaking apart, can be repaired to last for years



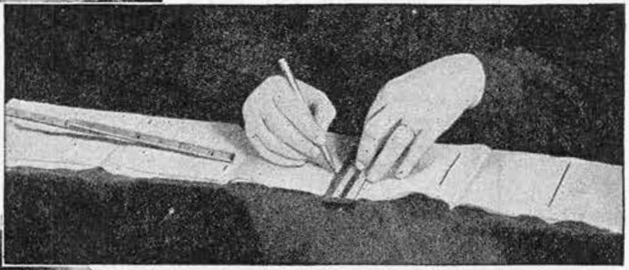
1 The first step is to clip the seam of cover across the back and about 6 in. down each side. The cover is then stripped from cushion like a glove from the hand as shown. Turning back the top layer of padding exposes the springs



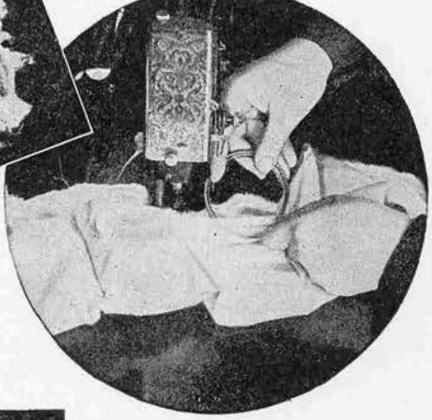
2 The tangled springs may quite easily be separated by unscrewing one from another. Place them in order upon the table to await the new covering



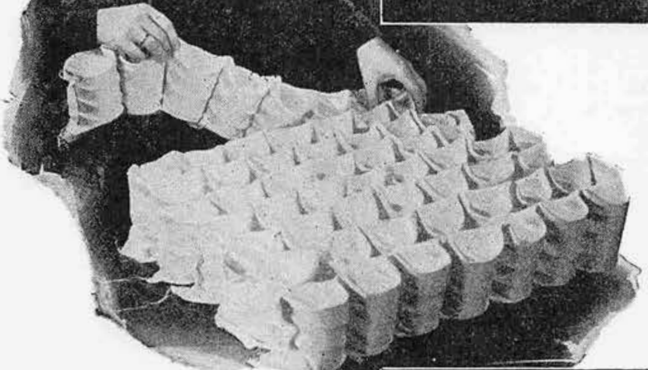
3 Impressions left by the springs should be counted next to find out the dimensions of the spring pad. Then cut a strip of unbleached muslin four times as wide as cover's boxing



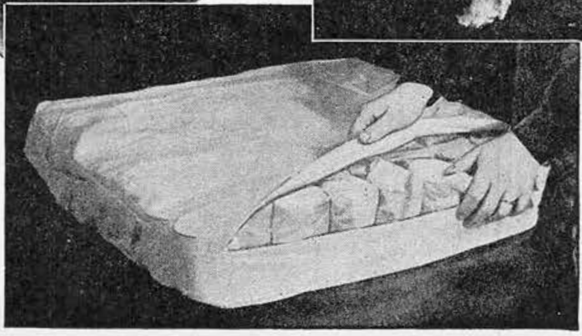
4 *Left:* Fold muslin lengthwise. Mark pockets ½ in. from end and at intervals of 1½ times spring diameter plus ¼ in., leaving space equal to diameter at end of rows. Then double seam pockets as marked



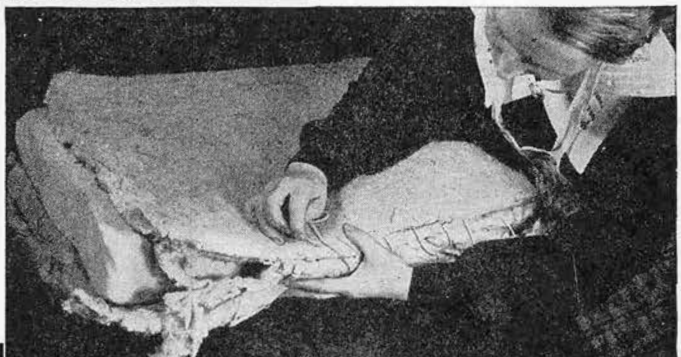
5 *Circle:* Place strip in machine lengthwise. Start closing seam ½ in. from open edge of goods. Compress spring and slip to bottom of pocket. Complete seam across pocket



6 A vigorous shaking will snap the springs into proper position in the pockets. Assemble on a flat surface and tie rows together, top and bottom, with large needle and twine at points of contact of the springs



7 Make a boxed slip cover of muslin for the spring pad, having a very snug fit. Compress springs slightly if necessary in order to pull on as illustrated in photo at the right, making certain that the springs are arranged correctly in their places



8 The final step is to place the spring box between the layers of felt and sew the latter together at the edges with grocer's twine, using a large needle. Then replace in original cover. Any depressions along the edges may be filled out with cotton when cover is pulled on

Roomy Magazine Rack

DESIGNED IN LADDER-BACK STYLE

IN DESIGN, this large and decorative magazine rack resembles a Chippendale ladder-back chair.

Cardboard patterns should first be made of all the curved parts. Saw the pieces on the band saw or with a turning saw. Before sawing the curved rails, however, plane the ends of the board square and true.

The rails are joined to the uprights with two ¼-in. dowels in each joint. When the joints fit, the upper edges of the rails are rounded slightly with file and sandpaper, and the uprights are grooved as shown. This is easily done with a scratch stock. The sides are now ready for gluing and clamping.

The next step is to join the ends to the two sides with dowels. Cut the ends so that the grain runs horizontally from side to side, not up and down. The center partition is joined to the ends by means of stopped dado or gained joints. A groove ⅛ in. deep is cut along the center of each end piece. It should be equal in width to the thickness of the partition and should stop about ½ in. from the top of the ends. When the joints are fitted, the sides, ends, and center partition are glued together.

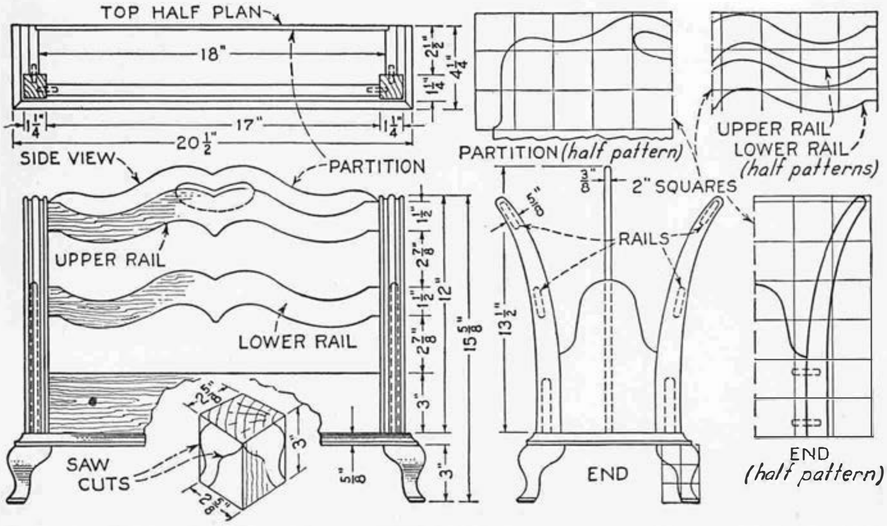
The bottom, the edges of which may be molded on a shaper or with a scratch stock, is now screwed in place. The feet should be made from one piece, which is squared to dimensions and then cut into 3-in. lengths. The pattern is marked as shown. One side is cut on a band saw to within ¼ in. of the top; the other side is then cut through, after which the first cuts are completed. The legs are smoothed with file and sandpaper and fastened to the bottom with glue and screws.

The magazine rack should now be thoroughly inspected and sanded. It is given a coat of stain and high-lighted when dry by rubbing with No. 2/0 steel wool or sandpaper. It may then be given three or four coats of very thin shellac. A 5-lb. cut of shellac should be reduced 50 percent by the addition of denatured alcohol. Rub between coats with No. 2/0 steel wool. The last coat may be rubbed to a smooth finish with waterproof sandpaper No. 6/0 and crude oil. Properly applied, this will give a beautiful, lasting finish that will make this rack equal to any piece of furniture in your home.

List of Materials

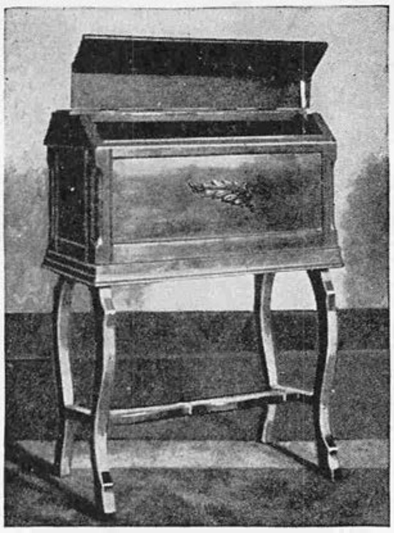
No. of Pieces	Description	T.	W.	L.
1	Uprights (4)	1¼	4½	24½
2	Curved rails (4)	⅜	5	17
2	Straight rails	½	3	17
2	Ends	½	8	5
1	Center division	⅜	13½	18¼
1	Bottom	⅝	8½	20½
1	Legs (4)	2⅝	2⅝	12½

NOTE: Dimensions are given in inches.



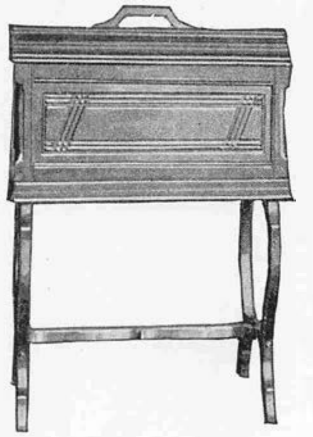
Side and end views, half of the top plan, half patterns of curved parts, and layout for feet

SEWING-MACHINE COVER SERVES AS CABINET



OLD-FASHIONED sewing-machine covers, which are still to be found stored away in many attics, can easily be converted into useful and attractive sewing cabinets. The one illustrated was made from a walnut cover by adding legs to make it 25¼ in. high, exclusive of the handle. The top was cut in two parts to make the lids, and a 1⅛-in. piece was fastened across from end to end so that the lids and handle could be attached to it. A tray 1½ in. deep and half the size of the cabinet was made to slide on ¼ by ⅜-in. strips glued to the sides.

The legs and stretchers were cut from ¾-in. stock and assembled with dowels. The top of the legs, which were left straight for 1 in., were set into the box and fastened with glue and screws. Of course, the legs could be turned or designed in any way preferred. The handle was cut from 9/16-in. walnut and fastened to the 1⅛-in. piece with screws from underneath.



The box part of this walnut sewing cabinet is the cover from a discarded sewing machine

INK FOR WRITING ON METAL

WRITING can be done on metal surfaces with equal parts of copper sulphate and potassium chlorate, dissolved in sufficient water to make a strong solution. A quill pen should be used. The writing soon turns into an intense, permanent black.

Graceful but Easy to Build...

A Colonial Corner Cabinet

For the display of treasured ornaments, this corner cabinet fills a need that exists in almost every home, and it is also attractive in itself

BEAUTIFUL little pieces of pottery, vases, decorative metal work, and other bric-a-brac are accumulated in every home. No better place to display them could be found than this tall, graceful Colonial cabinet. It will brighten up the corner of any room. For so fine a piece of furniture, the construction is relatively simple. The original cabinet was built of red gumwood, finished in Vandyke brown, but any cabinet wood may be used.

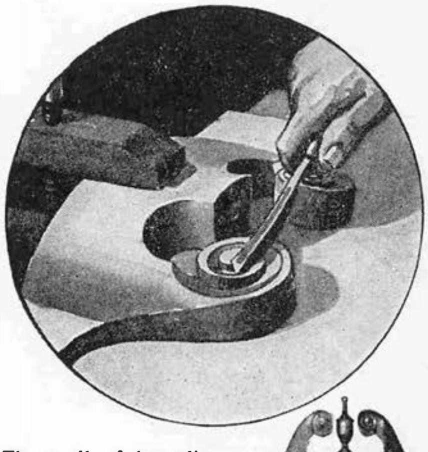
First cut the sides to length, dress and shape the ends, and sand them. One edge of the wider side must be rabbeted, so that both sides may be fitted and nailed together to form a 90-deg. angle.

The shelves now should be cut as in Figs. 4 and 7 from a board ¾ by 8½ in. The grain should run as indicated in Fig. 4. Free-hand curves are often preferred for the fronts of these, but compass curves could be substituted. The beading should then be cut along the front edges of the shelves as in Fig. 6. If a shaper or an electric router is not available, these may be cut with a carver's V-tool. The fluting on the vertical strips, at the edges of the cabinet, may likewise be cut with a carver's gouge of the correct size.

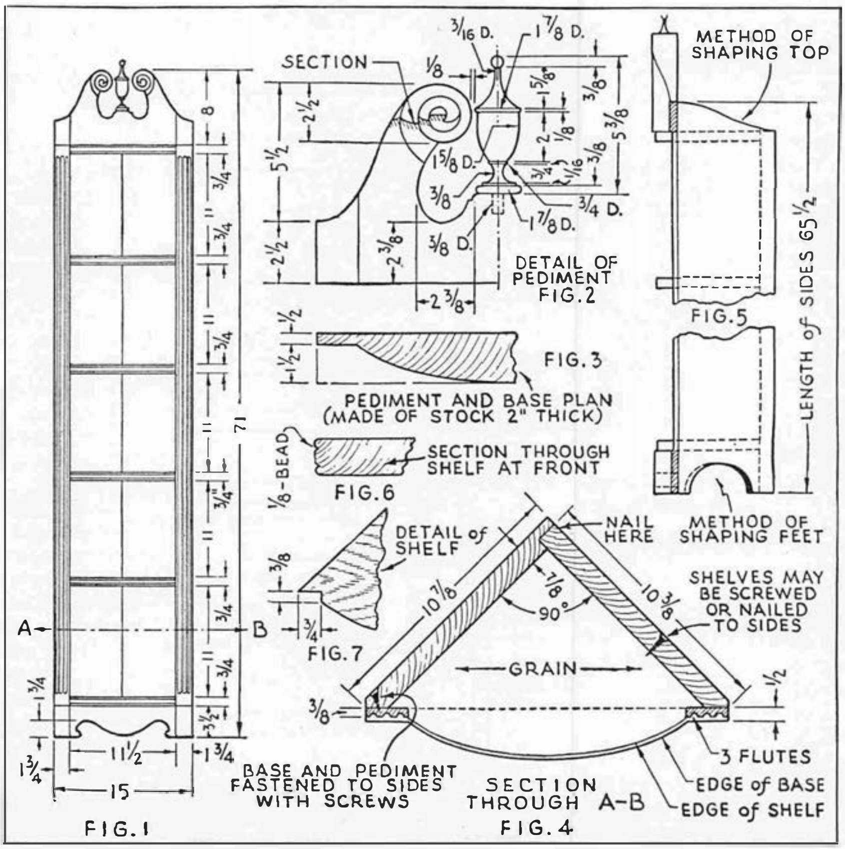
When the six shelves have been nailed into place, lay out the top edge of the pediment (Fig. 3) with a cardboard pattern on a piece of stock 2 by 8 by 15 in. This may be cut to the correct contour with a chisel, as the piece is almost too wide to be cut on the band saw; nevertheless, if a sharp saw blade is used, it can be done. Next lay out the shape shown in Fig. 2, turning the pattern over to get the other half, and saw it out. To carve the Ionic scroll, first cut around the lines with a carver's V-tool, then finish by shaping with a carver's flat gouge, as shown in the cross section detail of Fig. 2. Proceed in a similar manner to shape the ornamental base.

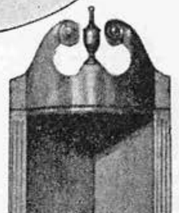
The base should be fastened to the sides with screws from the back as indicated in Fig. 4. Next fasten the fluted strips, and finally the pediment. The finial, which is turned in the form of a classic urn, is fastened by means of the small dowel turned on its base.

On the piece shown, the finish consisted of Vandyke brown oil stain, followed by a wash coat of shellac, and two coats of a high-grade floor varnish. The final coat was rubbed with pumice stone and oil to give a smooth, velvety finish.



The scrolls of the pediment are first outlined carefully with a V-tool, then finished with a flat woodcarving gouge





The original piece was made of red gumwood, stained Vandyke brown and varnished. At left are the complete assembly drawings with all essential details

DURABLE Tile-Top Tables

BUILT WITH EITHER WOOD OR METAL FRAMES

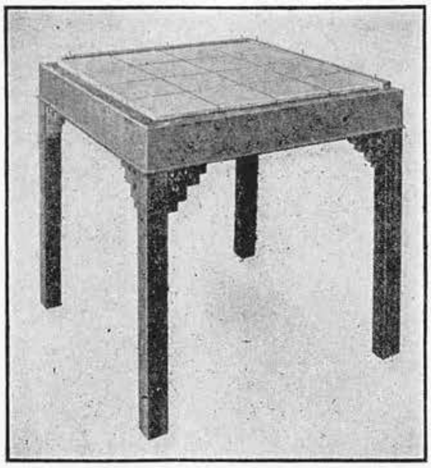
TABLE tops made of tiles may serve various purposes, but they are especially useful for coffee tables or smoking stands because they are neither damaged by hot or cold liquids and alcohol nor burned by cigars or cigarettes.

Before beginning the construction of such a table, it is important to select the tiles. Bathroom tiles, obtainable everywhere, are the least expensive, but they are not as decorative as hand-made tiles, which come in an endless variety of patterns.

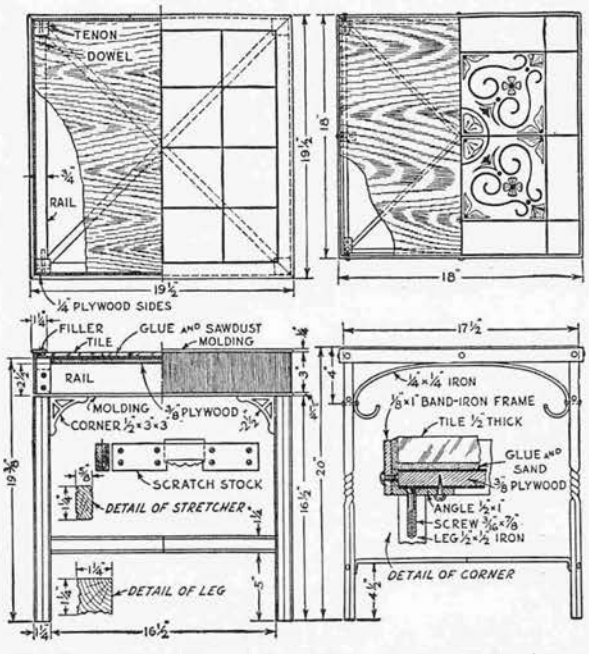
Having selected your tiles, build the table according to the dimensions of the tiled top. The top of the wooden table illustrated was made of sixteen pale bathroom tiles, each 4¼ in. square and ¼ in. thick. A checkerboard pattern can be obtained by using tiles of different colors or by using two shades of the same color.

The wooden table is designed in the Chippendale style. The legs and rails are first sawed and planed to dimensions. The two outside surfaces of each leg may be shaped with a scratch stock — a cutter made from a thin piece of steel clamped between two pieces of wood. A piece ¼ in. thick and 2⅞ in. long is cut from the two outside surfaces on the upper end of each leg to make room for the ¼-in. plywood sides. Two of the rails are joined to the legs with a through mortise-and-tenon joint, and the other two with dowels passing through the tenons. The stretchers are joined to the legs with dowels.

The base for the tiles is made from a piece of ⅜-in. plywood, fitted around the legs and planed flush with the outside surfaces of the rails. It should be glued or screwed to the upper edge of the rails. The tile are fastened to the base with casein glue, to which sand or sawdust is added to make it thick enough. A layer of this paste, about 3/16 in. thick, is spread over the base, and the tiles are pushed into it until they are flush with the filler strips, which should be nailed in place beforehand. If necessary, the joints may be pointed afterwards with the same mixture. After this is dry, the molding and plywood sides are mitered and glued in place. The plywood sides should be cut so that the grain runs up and down as shown. The corners are made from ½-in. stock and glued in place.



Wooden table designed in Chippendale style with tile top and, above, table made of iron



Working drawings of both the wooden and iron tables. Slight changes have been made in the wooden table, and stretchers added

ANY table may be fitted with a tile top simply by cutting a hole of the desired dimensions in the old top and screwing a piece of ⅜-in. plywood to its underside. Some blocking may be necessary in order to bring the tiles flush with the top, depending upon the thickness of the table top and the tiles being used.

The woodwork may now be stained, in a shade to suit the builder's taste, then it is either varnished or shellacked. These steps should be done in accordance with the instructions in the chapter on painting and finishing.

An iron frame may also be made for a tile top. The one shown in the drawing does not require any welding or heating. The top may be made from sixteen bathroom tiles 4¼ in. square, or from four hand made tiles 6 in. square and ½ in. thick surrounded by a border of tiles or glass of a contrasting color—for example, black.

The frame is made of a piece of band iron ⅛ in. thick and 1 in. wide. This should be hammer marked with a ball-peen hammer and straightened, after which the corners are bent at right angles in a machinist's vise. It is riveted together in one corner with ⅛-in. rivets.

The four legs are made from ½-in. square iron and given a twist in the middle, so that the lower part is at 45 deg. to the upper part. This is done by clamping one end of the leg in the vise at the beginning of the twist and using a monkey wrench to turn the bar until the desired shape is obtained. If bent out of shape, the iron can be straightened with a hammer. Protect the twisted portion, however, with blocks of wood. With exception of the twisted parts, the legs should be hammer marked. The legs are fastened with machine screws passing through angle irons riveted to each corner of the frame (see detail).

The construction is further strengthened by diagonal braces riveted to the lower part of the legs, and four bent ¼ by ¼ in. pieces riveted to the legs and frame. These braces must be hammer marked before being bent.

The finished framework should be cleaned with steel wool, wiped off with benzine or turpentine, and given a thin coat of flat black paint or lacquer. When dry, this is rubbed with No. ½ emery cloth until the bright color of the iron shines through the black paint. Some parts are rubbed more than others. The table is now wiped off and either waxed or given a coat of clear lacquer.

The base for the tiles is made from a ⅜-in. plywood panel, which is fastened with screws to the eight angle irons. The tiles are glued to this base as previously explained.

Picturesque Spanish Table

ORNAMENTED WITH IRONWORK

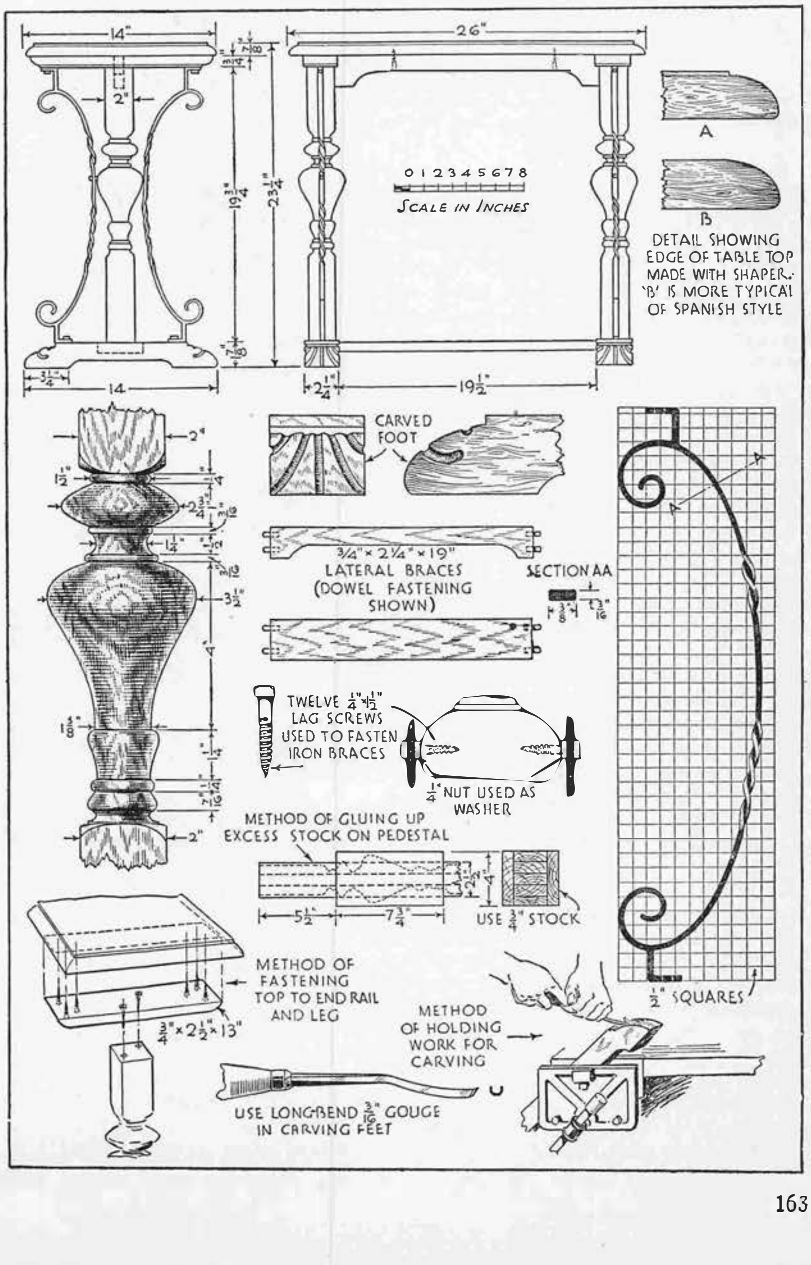
SPANISH type furniture, of which this table is an attractive example, is always direct and simple in construction, therefore easy for the amateur craftsman to build. This piece may be used as an end table, a small serving table, or a book table.

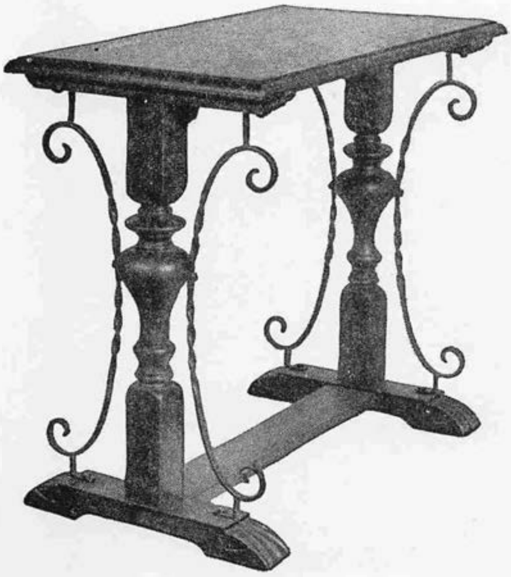
White oak is the most appropriate material for furniture of this type; the second choice would be Honduras mahogany, although mahogany is the better wood for carving. In construction, the project is so simple as to require little comment in addition to the information given in the drawings. It will be noted that a built-up pedestal or leg is suggested. The material is easier and cheaper to get in this form, and the piece is less likely to check and split. A little carving must be done on the feet, but is so easy that it will not prove difficult even to one with no experience in carving.

The ironwork is beyond the equipment of the usual home workshop and should be done by an ornamental ironworker. It will be easy to lay out the brace full size by drawing squares as shown and copying the design square by square. However, any competent ornamental ironworker can work directly from the design as given here. The iron is painted dull black. Slate blackboard paint makes a good finish.

When the table has been completed and given the final sanding, it should be stained dark brown—sometimes called Spanish brown. If the work is done in mahogany, brown mahogany stain may be used. The wood should not be filled. After staining, it should be given a wash coat of shellac thinned with from five to seven parts alcohol. When the shellac is thoroughly hard, rub it down with No. 2/0 or 3/0 steel wool, and polish with wax.

An antique effect is often given in order to simulate the appearance of age. This may be done by dusting rottenstone on the wood and rubbing it in, or it may be mixed with the first coat of wax and thus rubbed into the open grain.

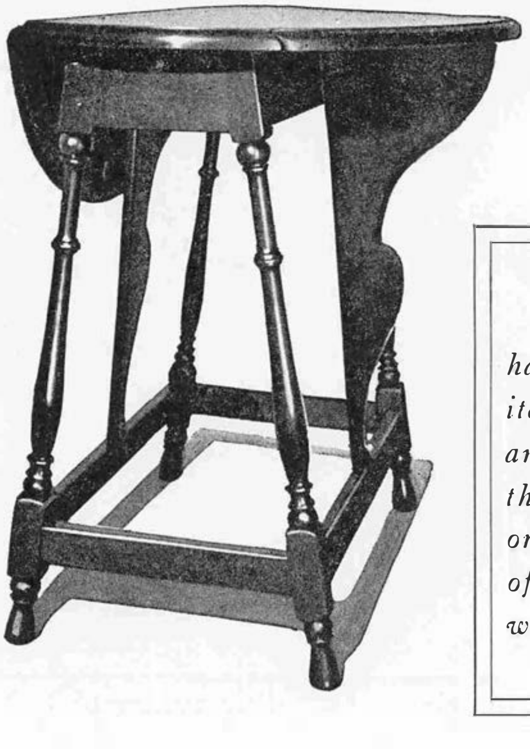

14"
2"
3/4"
7/8"
19 3/4"
23 1/4"
7/8"
3 1/4"
14
26"
2 1/4"
19 1/2"
0 1 2 3 4 5 6 7 8
SCALE IN INCHES
A
B
DETAIL SHOWING EDGE OF TABLE TOP MADE WITH SHAPER. 'B' IS MORE TYPICAL OF SPANISH STYLE
2"
1 1/2"
2 3/4"
1 1/4"
3 1/2"
4"
1 3/8"
7/16"
2"
CARVED FOOT
3/4" × 2 1/4" × 19"
LATERAL BRACES (DOWEL FASTENING SHOWN)
SECTION AA
3/8"
3/16"
A
A
TWELVE 1/4"×1 1/2" LAG SCREWS USED TO FASTEN IRON BRACES
1/4" NUT USED AS WASHER
METHOD OF GLUING UP EXCESS STOCK ON PEDESTAL
5 1/2"
7 3/4"
2 1/2"
4"
USE 3/4" STOCK
1/2" SQUARES
METHOD OF FASTENING TOP TO END RAIL AND LEG
3/4" × 2 1/2" × 13"
METHOD OF HOLDING WORK FOR CARVING
USE LONGBEND 3/16" GOUGE IN CARVING FEET



The design of this table dates from the finest period of Spanish furniture—from 1500 to 1630

A Colonial

THAT IS EASY



You can't match this table in the average store. Note the fine proportions, the turnings, and the butterflies

A butterfly drop-leaf table has been found to be a favorite home-workshop project among amateur craftsman, and the design presented here is one of the most graceful pieces of furniture to be found anywhere.

THIS useful little butterfly table, with its wings of graceful shape, bears the stamp of Early American design. For a correct period setting, it should be made of maple, the wood that is now reaching the full tide of renewed popularity. Walnut or mahogany, however, can be used with excellent effect.

Its small size and slender lines make the table suitable for association with almost any of the less formal types of furniture. No particular function is suggested because there is such a multitude of possible uses to which a small drop-leaf table may be put. No piece of furniture is more versatile.

There is nothing arduous about constructing this project as the parts are small and require an interesting variety of operations. Before beginning actual work, it is advisable to lay out the end view full size, not bothering, however, to work out the contour of the turnings unless it is desired to make a template for turning them. From this full-size layout it will be easy to determine the lengths of the aprons and the stretchers, as well as the exact angle to which they should be trimmed on the ends.

The leg stock should be cut 24 in. long and 1¼ in. square. Then lay out and cut the mortises. In making the original model, the mortises were routed out on the drill press as illustrated at the right after the turning had been finished, but by doing the mortising first, the danger of damaging the delicate turnings would be minimized. If a drill press is used in this operation, the mortises for the end pieces can be cut at the proper angle by tilting the drill-press table.

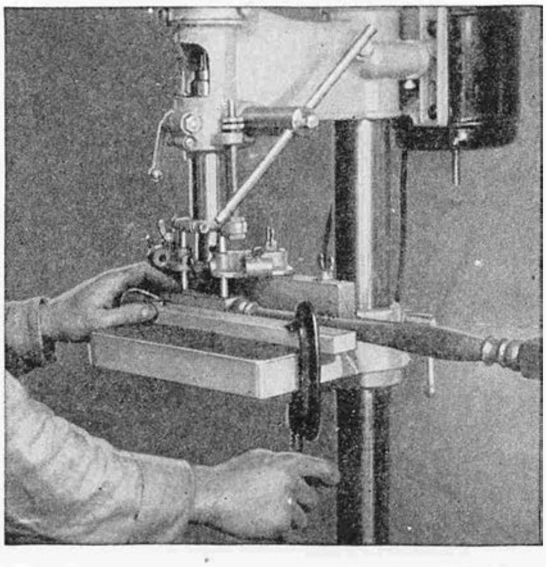
For the turning operation, be careful to locate the centers accurately. Use a steady rest to prevent any whipping and chattering of this long, slender piece, or run the lathe at a much slower speed than usual. The exact size of the end pieces should be taken rom the full-size layout. The side pieces are 16 in. long between shoulders. The stretcher is 13/16 by 1½ in. in section, and the apron 13/16 in. thick and 2 13/16 in. wide on the outer face.

After a trial assembly, glue up the ends of the frame separately. Level off the flush joint between the crosspieces and legs. Round the upper edge of the stretcher. Finish assembling the frame by gluing the side pieces in place. Test for squareness by measuring across the diagonals, placing a clamp, if necessary, across the longer one.

The wings may then be cut from ⅝-in. wood according to the layout on the drawings. A 5/16 by ½ in. strip of the same kind of wood is glued in a groove in the upper edge to strengthen it. Round off the back edge and drill for metal pivot pins, 3/16 in. diameter by 1 in. long. These may be made from a heavy steel wire nail of suitable size.

The solid top preferably should be glued up from boards about 4 in. wide. The center portion is 10 in. wide over all, and the drop leaves about 8 in. Finish all these to a uniform thickness. True up the abutting edges of the center portion and the drop leaves, and mold the section for the ruled edge joint. If molding cutters are available for cutting this curve, which must be a true radius, the job is simplified. If not, make templates of thin metal filed to the shapes shown in the drawings; then work the edges down till they fit the templates accurately. Most of the waste material may be cut out with the circular saw. A coarse round file and, finally, a round rod with sandpaper wrapped around it will be of assistance in finishing the concave section. The convex section on the center portion of the top can be brought to the proper contour with block plane and sandpaper.

Mortise the so-called "table" or "rule-joint" hinges flush with the underside of the top. Make sure, when locating them, that the center of the hinge pin is set exactly at the center of the radius of the joint as shown on the drawing. Sinking the hinges flush with the surface has the effect of raising the pivot point above the lower



Mortising one of the legs on the drill press. The table is tilted to cut mortises for the end pieces at the proper angle

Drop-Leaf Table
TO MAKE

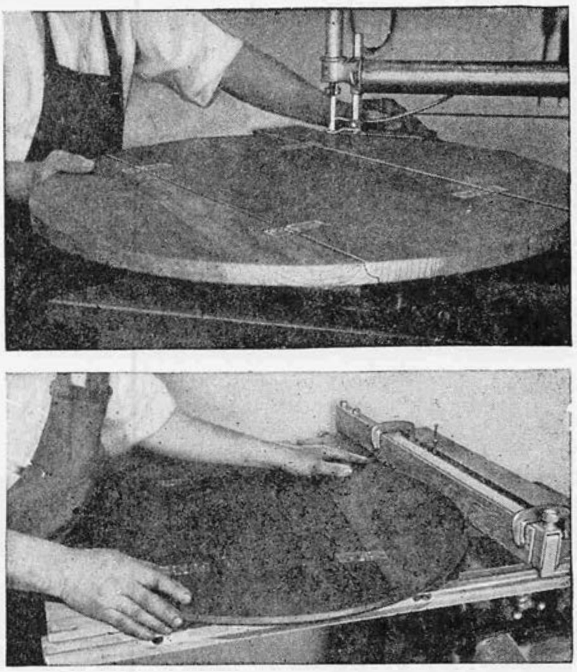
surface of the top, with the result that when the leaf is dropped, the hinges still remain concealed.

Now, with the three sections of the top still joined together, lay out the circumference and saw to the line as closely as possible. Finish to a smooth edge, free from any bumps or hollows. The molding may be done on the circular saw table with a molding cutter as shown in one of the photos. The top may be left assembled in doing this, but before molding across the rule joint, bevel back the corners, especially on the trailing edge, to prevent splintering them with the cutter. An alternative round edge is shown on the drawing that may be done with the block plane alone.

The pivot hole may then be bored in the center of the bottom side stretcher, and the top edges rounded off as shown.

Lay the assembled top face down on the bench and center the frame on it, fastening the two with four screws driven on a slant from the inside near each end of the side aprons, as shown in the section *C-C*. Locate the pivot point on the center line and about ¾ in. from the face of the side apron, being sure that the wing will swing without any interference. It will, of course, be necessary to remove the top in order to get the wings in place. Place a small steel washer under each wing.

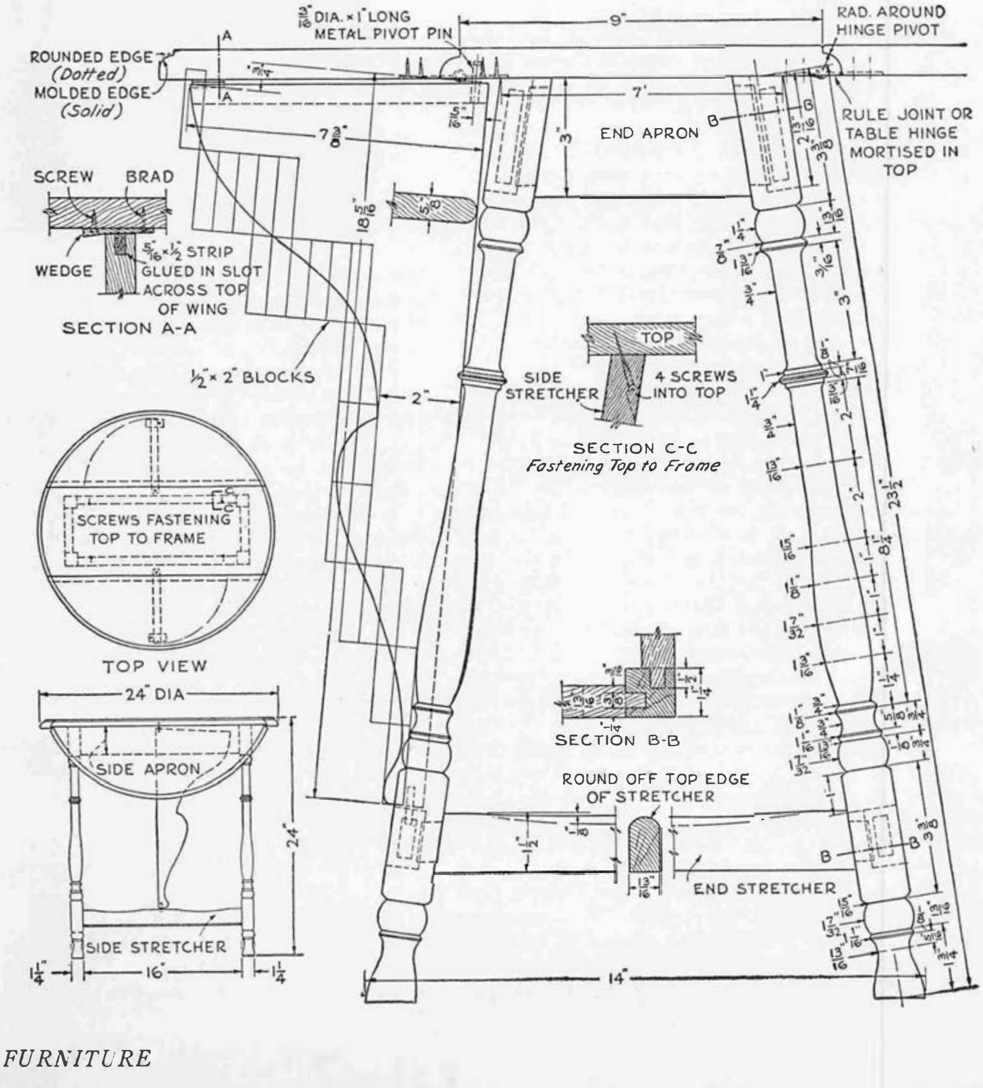
Wedges are screwed and bradded on the underside of the drop leaves so that they bear on the wings at their outer extremities when open. The wedges may be made concave on the underside and of such thickness as to level the top properly when the wings are open.


Sawing the assembled top to the finished outline and, lower view, molding the edge on the circular saw table with a molding cutter

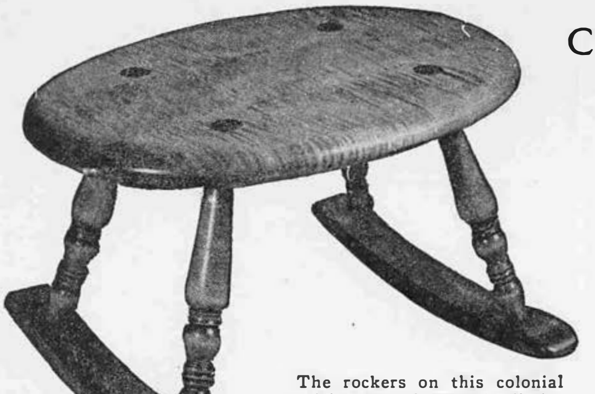
Take the table apart for finishing and remove all planer marks by scraping and sanding. Round off all sharp corners slightly. If an antique appearance is desired, carry out this rounding to a greater extent. Then give the bare wood a bath of water with a moist sponge or cloth. Let it dry thoroughly and sand off the raised grain. This treatment, besides reducing the amount of sanding required after the stain is applied, serves to bring out slight dents and grooves in the surface.

The desired color may be obtained by using water stains, in which case further rubbing down with No. 00 sandpaper or steel wool will be necessary. If an oil stain is used, no sanding will be necessary at this stage. If an open-grained wood, such as walnut or mahogany has been used, apply filler, stained to the proper color, rubbing it across the grain as the application becomes dulled through drying. Allow the filler to harden twenty-four hours or more, then varnish or lacquer the piece.

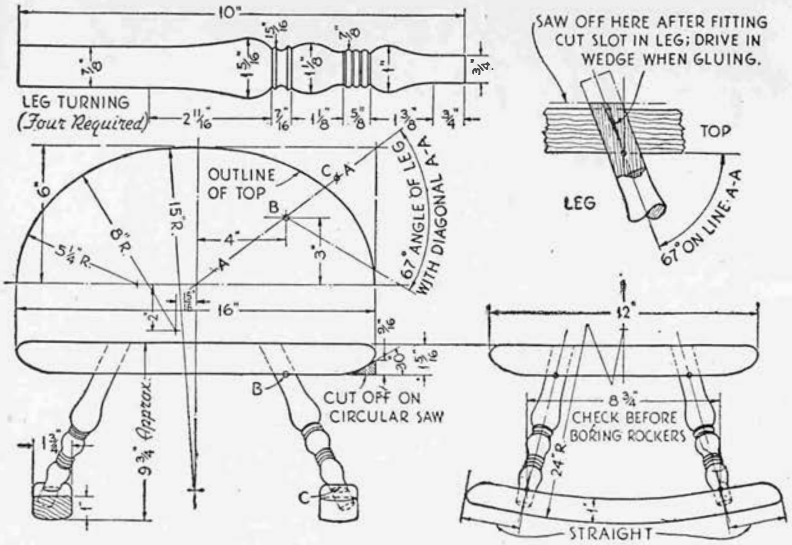
The original model was finished with three coats of thin lacquer—that is, two parts of lacquer to one part of thinner. Each coat was rubbed dull with steel wool. Two coats of wax were finally applied to give it a dull luster.



COLONIAL CRICKET WITH ROCKERS



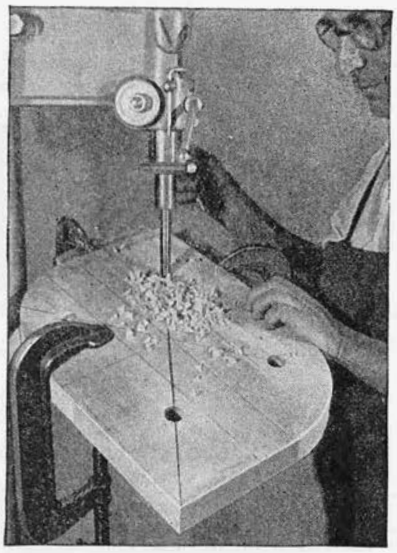
The rockers on this colonial cricket or footstool distinguish it from the usual type. The construction is as shown in the drawings at the right



ROCKERS set this cricket or footstool apart from the ordinary variety and make it doubly attractive to small children. Since the design is of Early American origin, the wood selected should be maple. If a distinctive effect is desired, pick out a piece of wood for the top having a fiddle-back figure. As it will probably be necessary to buy it in narrow widths in order to get figured grain of even color, it will be necessary to glue up three or more pieces to make the 12 by 16-in. top. Use a tongue-and-groove or spline joint and waterproof glue for the best results.

Square up the block and lay out the center line and diagonal *A-A* (see drawing). Locate on the bottom side the points *B,* where the holes for the legs are to be bored. Tilt the drill-press table to 67 deg. and clamp the top on it with the diagonal line running directly down the slope. Placing a waste piece of wood under the block to prevent injury to the boring tool. A bit of the Forstner type does the best job with this set-up, if available. However, if a small pilot hole is first made with a twist drill, the large hole can be made with an ordinary brace bit used in the drill chuck, provided the square shank has been sawed off. In thus adapting an ordinary bit for the drill press, it is advisable to file off the conical threads on the pilot.

Because of its irregular grain, the figured maple is finished by scraping and sanding. The leg holes are bored in the top by tilting the drill-press table as illustrated at the right, although this may be done by hand



The surfacing of the top cannot very well be done by planing, if figured wood is used, as the grain is too irregular. Use a sanding machine or a cabinet scraper, as shown in one of the illustrations. Then band-saw the wood to shape and round the edge. Most of the wood on the lower edge may be trimmed off on the circular saw tilted to 30 deg. In this operation be careful not to roll the top—push it straight forward so the saw will not jam, and take many successive cuts to get the curved outline. Block plane, wood rasp, sandpaper, and scraper may be used to finish the edge to the proper contour.

Make the turned legs next, fitting them to the top. When they are in position, check the distance between each pair near the bottom (the dimension marked 8¾ in. on the end view). With this checked dimension, locate the holes to be bored in the rockers, as soon as the rockers have been dressed to outline. The necessary holes at these points may also be bored on the drill press by tacking leveling blocks under the rockers. The waste pieces from which they were sawed may be used for this purpose. Tilt the drill-press table to the same angle as before, and on it clamp the rockers at a 45-deg. angle with the slope of the table.

After all rounding of edges and sanding have been done, the legs may be glued in the top. Secure them with wedges driven in a saw cut in their upper ends. The lower ends must be sprung together slightly to enter the holes in the rocker.

A desirable finish for this piece is a water stain to bring out the grain pattern, with two coats of varnish, rubbed down with pumice stone and waxed.

In rounding the top edges, much of the waste stock may be removed on a circular saw table

CHISELS SHARPENED ON BUFFING WHEEL

THE so-called "wire" edge on wood-cutting tools (chisels, planes, gouges, and pocket-knives) can be quickly removed with water and pumice stone on a cloth buffing wheel. Lift the tool from buff frequently and use plenty of water and light pressure to avoid injuring the temper. This is especially handy on gouges.

EASING RODS INTO CURTAINS

TO MAKE it less difficult to insert curtain rods into curtains, squeeze an aluminum thimble until it is flat enough to fit over the end of the rod.

GRACEFUL
Coffee Table
OF WROUGHT IRON AND WOOD

This unique coffee table, a pleasing addition to any home, can be easily constructed in the average workshop even if equipment is limited

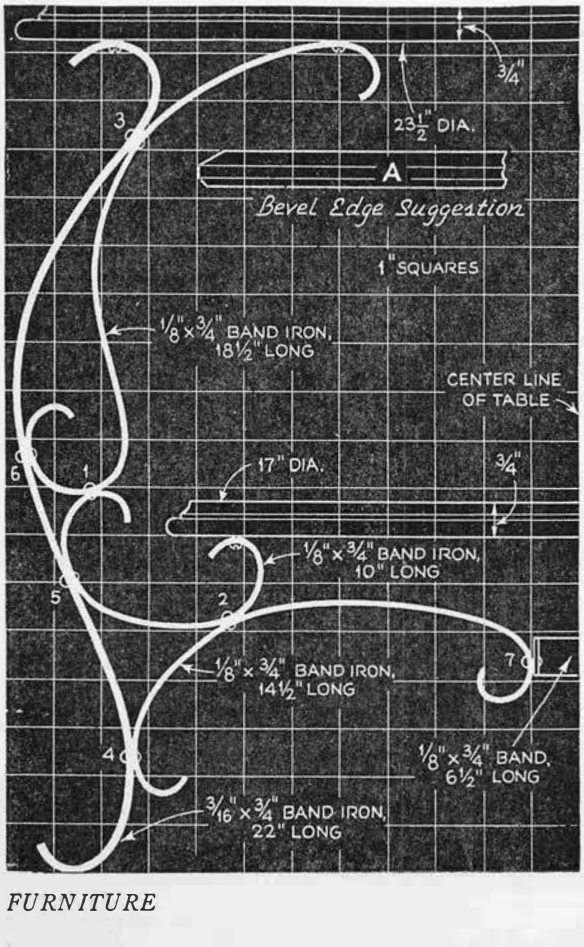
TO CONSTRUCT this coffee table of wrought iron and wood is not at all difficult even in a home workshop where tools and equipment may be quite limited. The band-iron legs are readily shaped to the plotted curves and either riveted, welded, or brazed together before being fastened to the top and shelf with roundheaded screws.

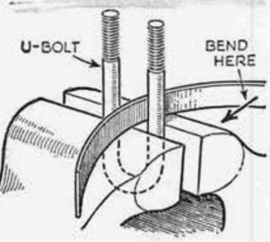
Black walnut, birch, or other 1-in. thick stock can be glued up for the top and shelf, and when dry, surfaced to ¾ in. or slightly less. The wood is then band- or scroll-sawed to form disks of the required size. In the case of the table illustrated, an old square piano top served to make the top and shelf. Since the core was of softwood, the edges were finished with the same enamel used on the legs.

After the edges have been sanded true and smooth, they may be shaped, or in the absence of a shaper, they may be chamfered top and bottom to break the severity of the sharp corners as shown in the sketch at *A*. Carefully scrape and sand the finished parts and apply stain, filler, and varnish coats to bring out the full beauty of the wood.

There will be numerous intervals while working on the top and shelf when one's attention may be turned to the leg construction. A full-size sketch should be made of the leg curves as a guide for shaping them and fitting the parts together. This lay-out may be made on paper or on the bench top with chalk since no heat is used in shaping. Note that the main stem of the leg is thicker than the other parts.

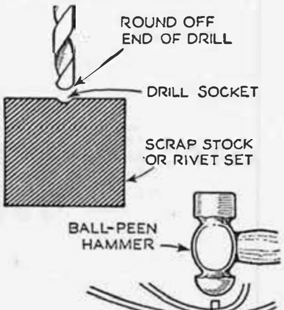
The shaping of each piece is accomplished by a series of slight bends following close upon each other as the stock is advanced between the ends of a U-bolt held as shown in a vise. Care must be taken to make the bends close together and square across the stock. If they are too far apart, the curves will appear bumpy or flat in spots. If the parts do not lie flat after shaping, they are best straightened by gripping the sides in a vise and bending.


3/4"
23½" DIA.
3
A
Bevel Edge Suggestion
1" SQUARES
1/8"x3/4" BAND IRON, 18½" LONG
CENTER LINE OF TABLE
6
1
17" DIA.
3/4"
1/8"x3/4" BAND IRON, 10" LONG
5
2
7
1/8"x3/4" BAND IRON, 14½" LONG
4
1/8"x3/4" BAND, 6½" LONG
3/16"x3/4" BAND IRON, 22" LONG



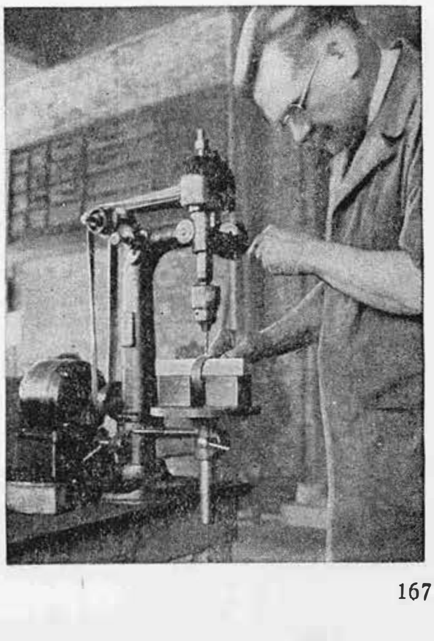
Method of Shaping Band Iron in Vise

Each wrought-iron band is shaped through a series of slight bends as it is drawn through the U-bolt in vise



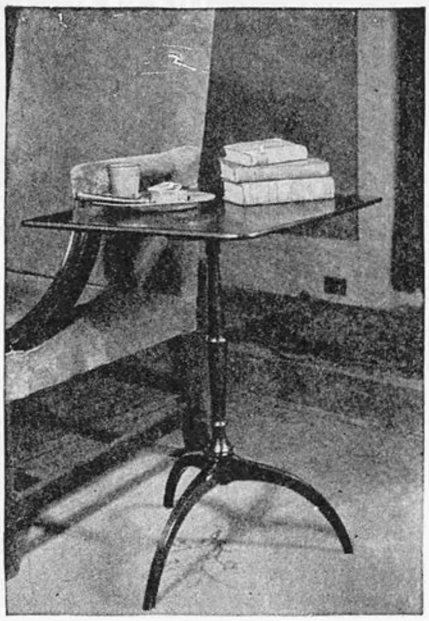
Showing How No. 6 Joint is Riveted

The bands of iron must be carefully center punched drilled, and then riveted as illustrated above. The photo at right shows how to drill the rivet holes. At the left is the pattern



ANTIQUE Tip-Top Table

Measured drawings of a beautifully proportioned eighteenth century piece



THROUGH the harmonious repetition of straight lines and tapers, an unusual perfection of design has been achieved in this eighteenth century mahogany table. The original—a genuine antique—is shown in the photograph. It should be noted that the tapered portions of the column are not perfectly straight, but have slight fullness that overcomes any feeling of skimpiness.

The material should be mahogany or walnut, although maple may be used. In turning the column, try to get a crisp effect by not rounding any edges that should remain sharp and distinct. This should also be kept in mind when using sandpaper. Use No. ½ sandpaper first; then finish with worn No. 0 grade. All sanding is done with the lathe running at full speed. A series of fine lines will be left running around the work; these are removed by sanding up and down with the grain while the lathe is not running. Use a piece of well-worn fine sandpaper for this. The work is then taken out of the lathe and the surplus ends sawed off.

The top end of the column is cut down from the round to form a square tenon 1⅛ in. on a side. This fits snugly into a corresponding mortise cut in the block, which should be glued in place and fastened with a dowel passing through the side into the tenon on the column.

The feet are mortised to the column. A template made from good stiff cardboard is necessary to get the mortises at the right angle. Measure the diameter of the base of the column and make the radius of the arc exactly half. The width of the projecting portion of the template should be measured from the center line. With a pair of dividers, mark off three equal spaces on the shaft. One mark should be directly in line with the center of the block on the other end of the shaft. This is necessary to insure the top being equally in line with both forefeet when it is tipped up. When laying out the mortises, it is advisable to clamp the base of the shaft lightly in a vise. Get the space mark in the center of the vise jaws; the edges of the vise can then be used as guides. Drill with a 5/16-in. bit and use the template frequently while chiseling out.

The feet are made of straight-grained wood free from any defects, the grain running in the general direction of the feet. Time will be saved by laying out a foot on cardboard and tracing all three feet from it. Saw the feet on a band saw and plane them to the required taper. Finish the curves with spokeshave, file, and sandpaper. Cut the tenons one at a time to fit the shaft snugly, and number each with its corresponding mortise. The end of the feet that fits against the shaft will have to be worked down with a gouge until a close joint is obtained.

To glue the feet, put a wooden hand screw on the foot so that it is parallel to the shaft when the foot is in place. An iron C-clamp may then be used to draw the foot down, one part bearing on the wooden clamp and the other part on the shaft. A block of soft pine should always be placed between the clamp and the work. Clamping in this manner will allow only one foot to be glued at a time, but the joint will be stronger than is possible to get in any other manner.

The top of the original table is made up of two pieces 10½ in. wide and 18 in. long. Glue the pieces together, plane the surfaces, and select the better for the top. Plane the edges, draw 1-in. arcs at the corners, saw the corners, and finish with file and sandpaper. Sand all edges enough to remove the sharpness.

Make the two cleats as shown and fasten them to the top 4 in. apart with screws of various lengths. The top of the front edge of the block, which is pivoted between them, is rounded to allow the top to tip up. Two screws are used as pivots. A catch of the type especially designed for tip tables should be fastened to the top to hold it in place.

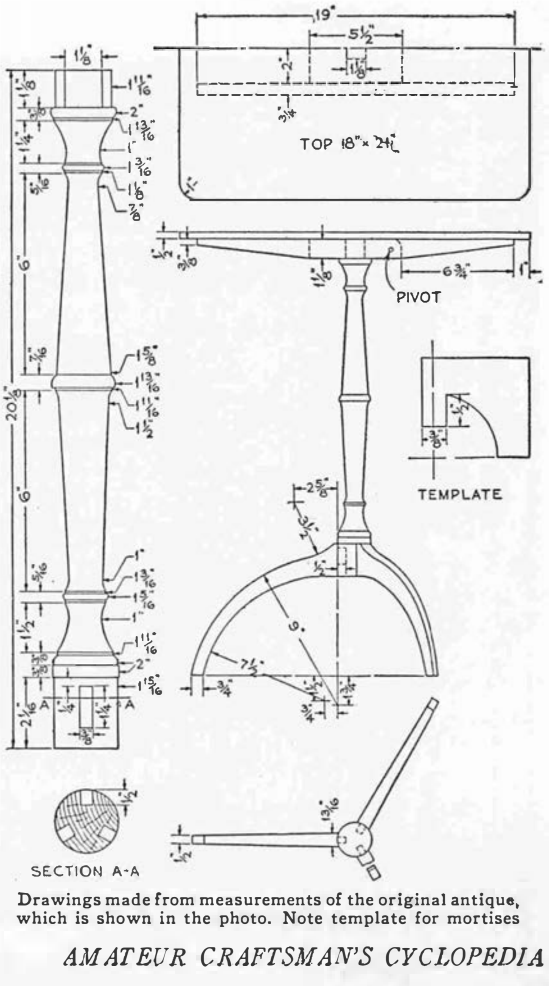
The work is now smoothed all over with No. 00 sandpaper or fine steel wool and dusted off. Regular oil stain, brown or red in color, may be used. With a little more trouble, however, a stain preferred by some craftsmen, may be made—ten cents' worth of potassium bichromate mixed with a pint of water. If this or any other type of water stain is used, the work will have to stand for an hour to dry. It should then be rubbed with fine steel wool, as the water raises the grain of the wood.

A coat of paste wood filler is next applied. If the proper color is not at hand, a few drops of regular oil stain may be stirred with natural wood filler to obtain the right shade. The filler is brushed on the work, a small portion at a time; and when it shows signs of drying, remove the surplus by rubbing across the grain with a cloth. Allow the filler to dry overnight. Two coats of thin shellac are then applied, rubbing with steel wool after each coat.

List of Materials

No. of Pieces	Description	T.	W.	L.
1	Top	½	18	21
2	Top cleats	¾	1⅛	19
1	Column	2⅛	2⅛	22
1	Block	1⅛	4	5½
1	Feet	13/16	7	12½

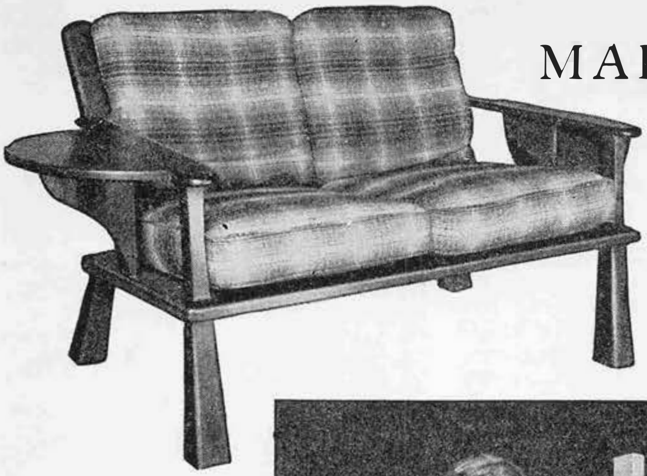
NOTE: Dimensions are given in inches.



Drawings made from measurements of the original antique, which is shown in the photo. Note template for mortises

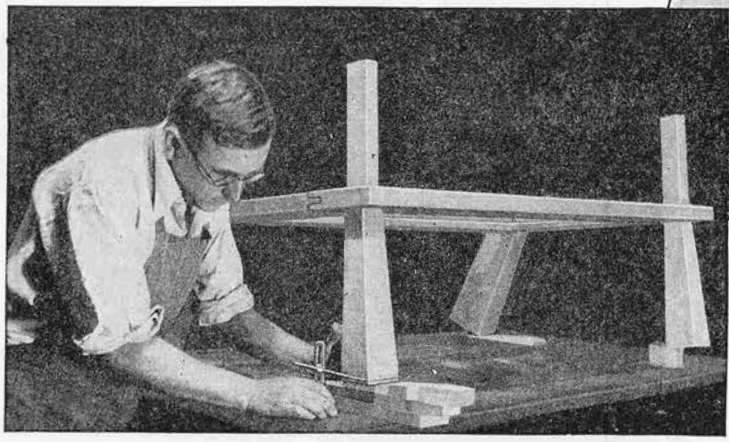
MAPLE Love Seat

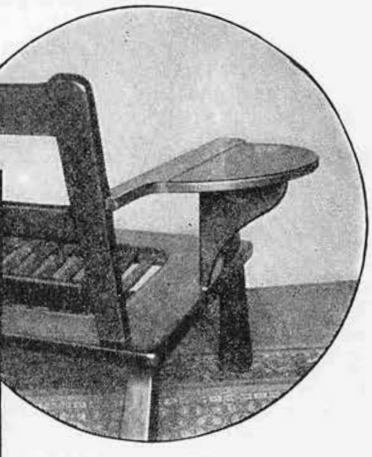
COMBINES SIMPLICITY, BEAUTY, AND COMFORT



Although of Early American design, this piece is quite modern in comfort. It has inner-spring seat cushions and stuffed back cushions

A
Special Design
in
Early American
Style





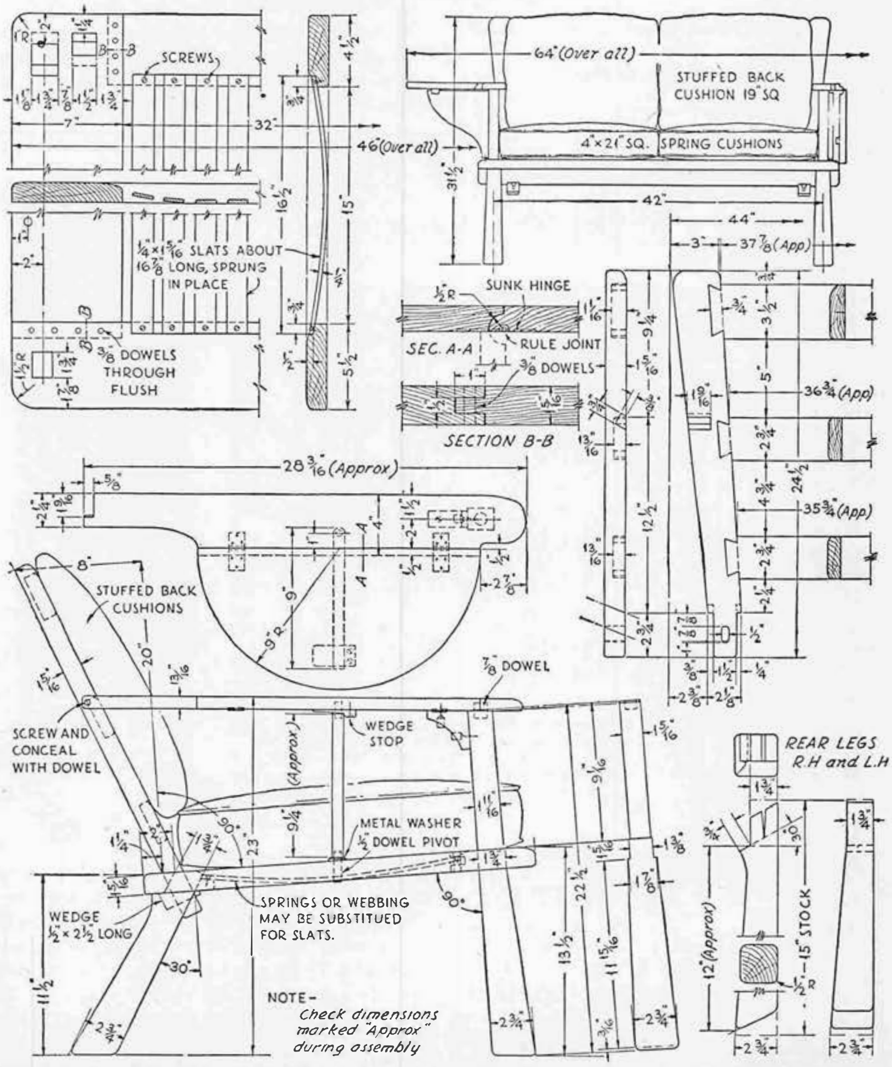
Rear view showing the butterfly support for the drop leaf or extension arm. The slats that hold the seat cushions are also visible. *At left:* How the frame is blocked up so the legs can be scribed for cutting off

THE "eye appeal" of this Early American maple love seat depends on its outline, structural details, and finish. Its comfort is due to the modern inner-spring seat cushions and stuffed back cushions and the correct proportion of the seat and back angles. The straight lines and squareness of its design are softened by rounding off all sharp corners and edges.

Its construction does not demand exceptional skill nor extensive tool equipment; the prime requisite is care—care in selecting well-seasoned maple of uniform light color, care in making all joints accurately, care in planing, scraping and sanding the surface, and care and patience in finishing.

The following order of procedure is suggested. The dimensions marked "approximate" on the drawings should be checked during assembly, as they may vary because of slight differences in fitting the leg and back joints in the seat.

1. Cut and fit the seat frame.
2. Cut holes for legs and back post in the seat-frame members before assembling, as they may be more easily handled separately. This may be done by hand chisel or on drill press with router bit. If on the latter, the corners of rear holes may be left round, and the fitting parts rounded to fit.
3. Glue seat, peg the joints, and surface with plane and scraper.
4. Cut out legs; shape with file, plane, and scraper, and fit accurately to holes in seat.
5. With legs fitted in place, block up seat on a level bench so that the top front edge is elevated 15½ in. and rear top edge 13½ in., as shown in one of the illustrations. Scribe a line 2 in. from the bench top around each leg. A surface gauge is handy for this purpose. Remove legs and cut them off on the scribed line. Later cut off upper end of front legs on the line



Front view, end view, and details of seat frame, back, legs, and drop leaves. The dimensions are suitable for standard 21-in. square seat cushions, but may be modified to take other sizes determined in operation 7, and bore ⅞-in. hole in top.

6. Cut out back posts; shape and fit each to seat with draw-up wedge. Leave slat dovetail mortises till later.

7. With back posts in place, fit horizontal back slats, cut dovetail shape on slat ends. then scribe their outline on back posts. While back posts are still in place, put in front legs, marked with proper cut-off point at upper end, and level across to rear posts with straightedge to locate mortise for rear end of arms. This should be even with upper edge of the middle slat. Then remove posts and cut slat and arm mortises. Glue posts and slats together, first making sure that the posts will still enter their sockets accurately when assembled with slats.

8. Glue legs in place. Rear legs are assembled with wedges driven from the top into wedge-shaped slots sawed in the leg tenons. Use a sharp chisel and scraper to trim off the projecting tenons.

List of Materials

No. of Pieces	Description	T.	W.	L.
1	Back post	1 5/16	6	26
1	Seat slats	1 5/16	6	18
1	" front	1 5/16	6	48
1	" back	1 5/16	5	36
2	" ends	1 5/16	7½	22
2	Front legs	2¾	2¾	24
2	Back "	2¾	2¾	15
1	Back slat	1 1/16	4	40
1	" slats	13/16	6	40
1	Drop leaves and butterfly flaps	13/16	10	56
1	Arms	13/16	10	30

NOTE: All dimensions are in inches.

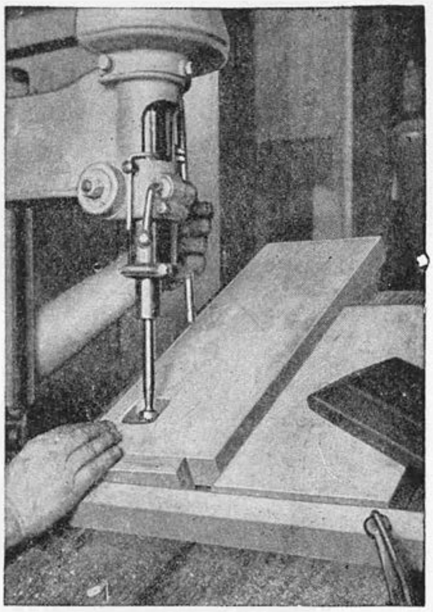
9. Glue the back in place on the frame.

10. Make up and fit arms to back and front legs with screws and dowel as detailed. Remove arm and fit rule joint and hinges to drop leaf.

11. Make up butterfly flap. With arm in place, square down from pivot peg glued in underside of arm to locate pivot dowel in seat. Leave this dowel long so that it can be removed from below. See that the flap is properly held up with the wedge stop in place. Take off the flap and drop leaf for finishing, and glue the arm in place.

12. Fit the seat slats and remove for finishing. Instead of the wooden slats shown, the usual interlacing flat steel bands with spiral springs at the ends may be installed. These will give a softer seat.

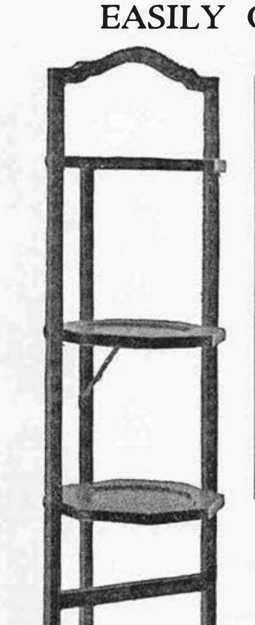
13. The finish should match other pieces if the settee is to be added to an existing group. The following method produces a lustrous reddish brown shade that brings out the beauty of the grain. First, moisten the piece all over with a wet rag to raise the grain, and sand off the fuzz when dry. Apply Early American water stain and sand lightly when dry. Two coats may be necessary to get the desired tone and to cover up any places exposed by sanding. Rub down hard with steel wool. To darken and produce a deep luster, you may apply a coat of transparent filler darkened with a small amount of walnut stain and thinned with linseed oil and turpentine. Seal with a thin coat of shellac and rub with steel wool. Repeat the shellac coat three or four times, and finally use a good furniture wax.

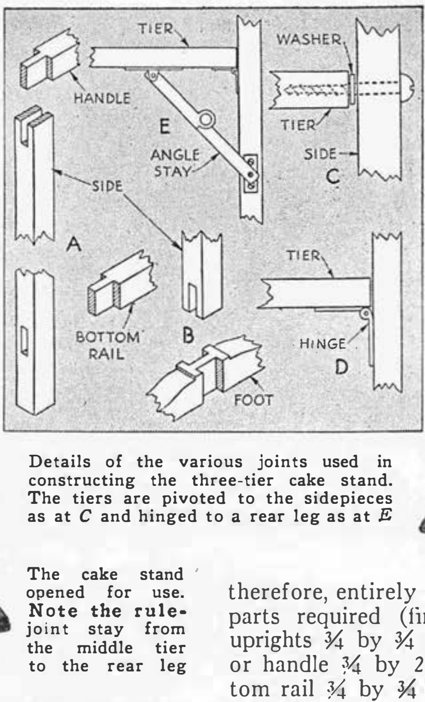

Boring holes in seat on tilted drill-press table. A router or a Forstner bit is used

The cushions may be obtained from a furniture store. The sizes given, 21 in. square for the spring seat cushions and 19 in. square for the back cushions, are common dimensions. If the cushions are not obtainable in these sizes, you may either have them made up by an upholsterer or alter the settee dimensions to suit sizes readily available.

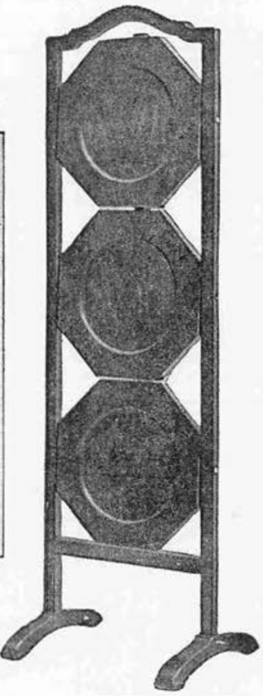
The original of this settee was built at a cost of $7.50 for the maple, $14.00 for the cushions, and about 50 cents for the hinges and finishing materials. The cost will, of course, vary in different sections, but, in any case, will be much less than the price of a corresponding piece of furniture.

LIGHT FOLDING CAKE STAND EASILY CARRIED AROUND


The cake stand opened for use. Note the rule-joint stay from the middle tier to the rear leg



Details of the various joints used in constructing the three-tier cake stand. The tiers are pivoted to the sidepieces as at *C* and hinged to a rear leg as at *E*



HERE is an extremely useful and attractive piece of furniture that any amateur craftsman can make. The choice of wood will be largely influenced by the other furniture in the room and is, therefore, entirely a personal matter. The parts required (finished sizes) are two uprights ¾ by ¾ by 34 in., one top rail or handle ¾ by 2½ by 11 in., one bottom rail ¾ by ¾ by 11 in., two feet ¾ by 2½ by 9 in., one back stay ½ by ¾ by 28 in., and three tiers ⅝ by 9½ by 9½ in.

How the handle and bottom rail are joined to the sidepieces is shown in the drawings at *A*. The first job will be to construct this part of the stand. Next make the joints for the two sides and feet as shown at *B*. When this has been completed, the handle and two feet should be shaped, and this part of the job cleaned up and glued together.

The three tiers should now be made and pivoted by means of a roundheaded screw, as shown at *C*. This is free to turn easily in the sidepiece, but is screwed tightly into the edge of the tier. A washer should be inserted between the two.

To prevent the plates or dishes from sliding off, the center of the tiers should be recessed. This can be done on a lathe in a very few minutes or, if a lathe is not available, the recess may be cut out with a router. If preferred, instead of recessing the middle, a strip of molding can be fixed around the edges.

In order to operate all the three tiers together, they are hinged to a wooden stay; this also forms an extra leg when the cake stand is in use, thus giving added rigidity. The position of the hinge is shown at *D*. A brass angle lid stay should be screwed to the underneath side of the center tier and on the side of the wooden stay at *E*. This keeps the three tiers rigid and prevents them tipping.

Finally clean up and finish the cake stand by whatever method you prefer. An excellent way is to use a water stain, paste wood filler if required, and several thin coats of shellac. One of the new wax-process finishes is even simpler—two coats of a special flat finish and one of commercial paste wax.

Novel Three-in-One Nest of Tables

The tables in use and, below, method of clamping legs to turned columns

NOVELTY and exceptional beauty of design are combined in this nest of tables. It differs from the usual types in that the additional table surface consists of two round-topped stands, which can be completely detached from the main table and placed anywhere in the room. This enables them to be moved where most convenient to serve refreshments to guests who are sitting at some distance from the table proper.

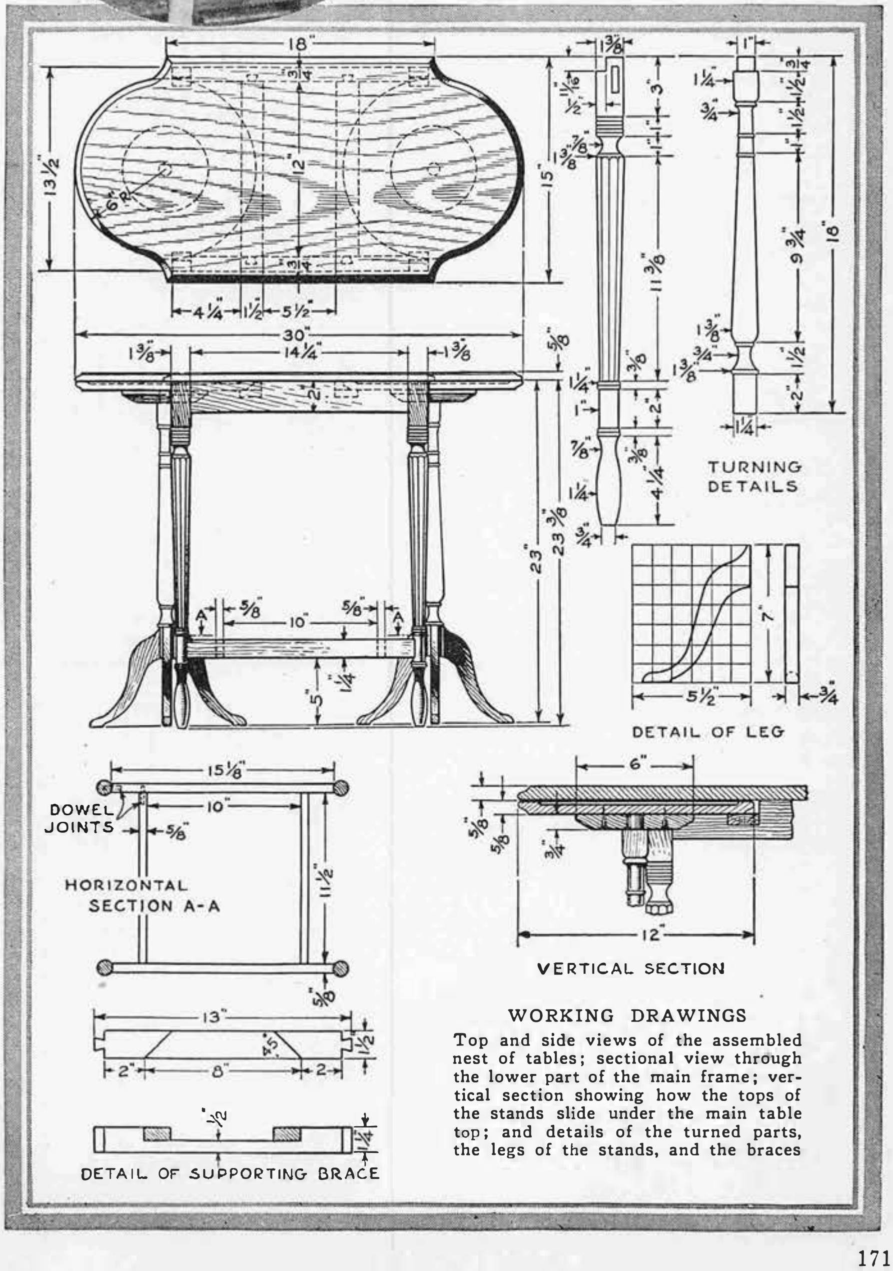
It is best to begin the work by making the two stands. Turn the two columns between centers and cut out the eight legs on the band saw. These are rounded and smoothed with file and sandpaper, and joined to the columns with two dowels each. The ends fitting against the columns are shaped to the right curvature by sanding on a spindle sander. A sanding device of this type can easily be made by turning a cylinder 1 in. in diameter and about 12 in. long. Glue to this cylinder a piece of No. 1½ sandpaper cut so that its edges just meet when it is wrapped around the wood. Glue is applied to the cylinder and the sandpaper is held in place by wrapping a piece of bandage or string around it. Rest the leg on the tool rest of the lathe and press it evenly against the revolving spindle sander as shown in one of the photographs. Test each leg with a steel square to see if the sanded surface is square to the part of the leg which is to stand on the floor.

Locate the holes for the dowels by gaging legs and columns with a marking gage. Two opposite legs are glued to the column at the same time and clamped with handscrews as illustrated.

The tops for the stands are turned by gluing them to waste stock with paper between. The top of each stand is fastened to the columns by means of a circular disk or plate, which is glued to the upper end of the column and screwed to the underside of the top.

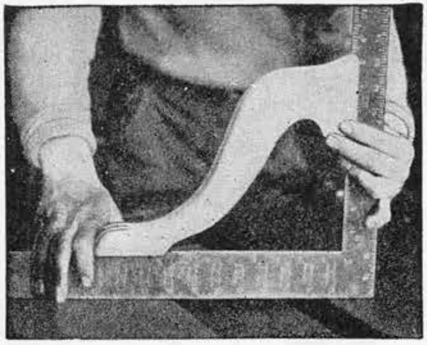
The construction of the main table

A sanding cylinder is used in the lathe to shape the legs to fit against column of stand



WORKING DRAWINGS

Top and side views of the assembled nest of tables; sectional view through the lower part of the main frame; vertical section showing how the tops of the stands slide under the main table top; and details of the turned parts, the legs of the stands, and the braces



When the legs have been sanded to fit the columns, they are tested with a steel square

is begun by squaring the four legs to dimensions and turning them. They may be reeded as shown or left plain.

The two rails are mortised into the legs. Each tenon should be about ¾ in. long. A recess ½ by 11/16 in. is then cut on the inside surface of each leg. This serves to support the stands. The two supporting braces connect the rails and form a third point of support for each stand. The stretchers are joined to the legs and to each other by means of dowels. The leg ends of the two stretchers are sanded on a ¾-in. spindle sander.

Glue the two sides together first. When these are dry, complete the gluing of the table. See that the two stands slide easily into place and make any necessary adjustments.

Glue up the top from two or more boards. It may be veneered, inlaid, or left plain. The edges should be shaped as shown, either by machine or by hand. The top is fastened to the table with screws through the braces.

A table of this kind should be made of some close-grained cabinet wood such as mahogany, walnut, gum, birch, or maple. If water stain is to be used, sponge the wood first with water and sandpaper again when dry to prevent the grain from being raised when the water stain is applied. After staining, the work is sanded lightly with No. 3/0 sandpaper, and one or two coats of *very thin* shellac are applied. Each coat of shellac is rubbed down with No. 2/0 steel wool.

Two or three coats of a good grade of rubbing varnish are applied on top of the shellac. Sand lightly between coats and let each coat dry thoroughly before applying the next. Be sure that you do the varnishing in a warm, dust-free room and clean the brush thoroughly in turpentine before applying a new coat.

Rub down the final coat with paraffin oil and No. 7/0 waterproof sandpaper.

List of Materials

No. of Pieces	Description	T.	W.	L.
4	Table legs	1⅜	1⅜	23⅜
2	" rails	¾	2	15¾
2	" stretchers	⅝	1¼	15⅛
2	" "	⅝	1¼	11½
2	" braces	1¼	1½	13
1	" top	⅝	15	30
2	Stand columns	1⅜	1⅜	18
1	" legs (8)	¾	8	20
2	" tops	⅝	12	12
2	" plates	¾	6	6

NOTE: Dimensions are given in inches and are finished sizes.

Good-Looking Doors

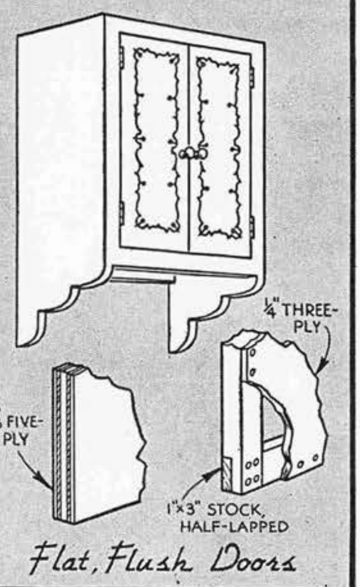
FOR BUILT-IN FURNITURE

HERE are four suggestions for making attractive small doors for cupboards, cabinets, and various types of what is usually referred to as "built-in" furniture—pieces made to fit a certain place.

Flat doors, hung flush, have no dust-catching projections like the ordinary paneled variety. They may be cut from 13/16-in. five-ply wood or framed together and sheathed with thin plywood, glued and bradded on. Paneled doors already in use can often be sheathed over in the same way. A striped or stenciled border takes away the severity of the plain surfaces. Decalcomanias or transfers also will make very attractive decorations.

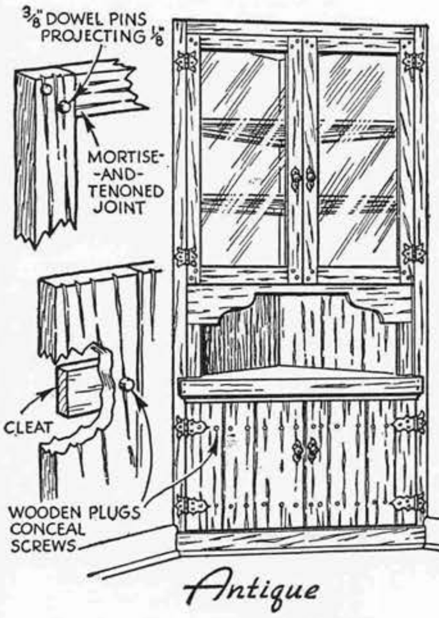
An antique corner cupboard of unusual charm is pictured in one of the drawings. The lower doors consist of boards of random widths screwed to cleats. The wood is "checked" by slashing it with a V-chisel. The screws in the lower doors should be countersunk and hidden with plugs projecting ⅛ in. After the cupboard is enameled, paint of a contrasting color is rubbed into the checks, and then rubbed off the surface with a cloth.

Half spindles can be used to make a door of Spanish or Italian design. In order to clean the glass, it should be mounted in a separate frame held in the rabbet with turn buttons.



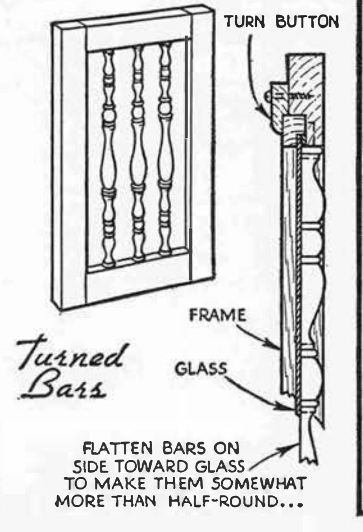
Flat, Flush Doors

By hanging your doors flush, all dust-catching projections may be eliminated. The severity of the plain surface is broken by borders


⅜" DOWEL PINS PROJECTING ⅛"
MORTISE-AND-TENONED JOINT
CLEAT
WOODEN PLUGS CONCEAL SCREWS

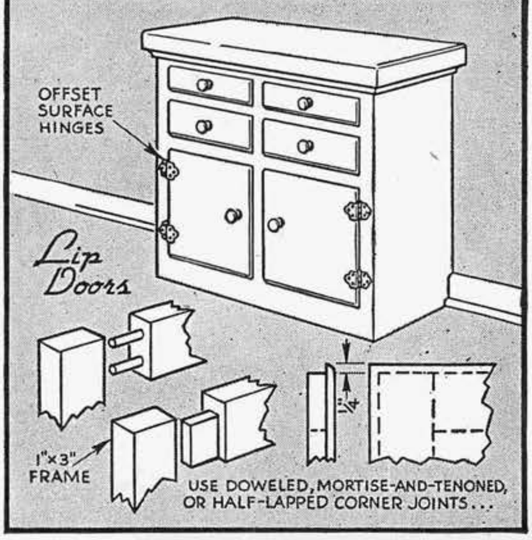
Antique

Random-width boards screwed to cleats form the lower doors of this corner cupboard. The wood is slashed with a V-chisel, and paint of a contrasting color is rubbed in the checks



Turned Bars

FLATTEN BARS ON SIDE TOWARD GLASS TO MAKE THEM SOMEWHAT MORE THAN HALF-ROUND...



Lip Doors

USE DOWELED, MORTISE-AND-TENONED, OR HALF-LAPPED CORNER JOINTS...

PAINTING and FINISHING

BETTER METHODS OF

Finishing Furniture *and other* Woodwork

ALL good things must have a sound and proper foundation. Let us assume, therefore, that your piece of furniture is well designed and well constructed.

The first thing to decide is just the color effect you desire in order that it will harmonize with whatever other pieces it is to be near. Only once in a great while can you have a piece which may be used as a high-light in a room because of its departure from the general tone of walnut or mahogany or maple, as the general finishes are named. Such an unusual piece has, however, been chosen to illustrate the first of this series because it embodies a number of methods and materials which would apply equally well to the standard finishes and woods. Pieces like the small table of American Colonial design shown on another page are assembled complete and trimmed, then taken apart as far as practicable for finishing, when made under home workshop conditions.

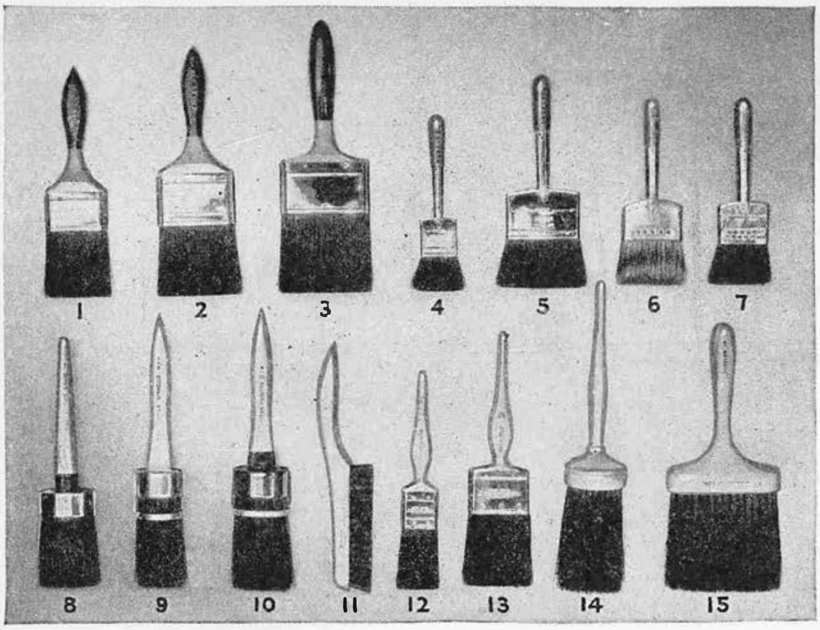
Every good mechanic understands the necessity for good tools in turning out a well-made product, and this is equally applicable to finishing. For sanding purposes use a hardwood block cut 1¼ by 3 by 5 in., with the top edges all rounded and the sides coved to fit the fingers. A piece of ¼-in. battleship linoleum should be glued on the bottom to prevent bumping moldings and to afford a certain amount of give to prevent line scratches while using a quarter sheet of paper. Similar blocks of hard rubbing felt cut from 1-in. and ½-in. stock to 3 by 5 and 2 by 3 in. are needed also. For cabinetwork, buy garnet paper, since this will outlast flint paper three to one. You should have Nos. ½, 0, 3/0, and 5/0. Do not discard pieces of 3/0 or 5/0 which have been used on clean wood; they will be useful in sanding finish coats later on.

Study the illustration of the half-sanded table top, which has been recently veneered and dried, then molded on the edge, and is now being cleaned up for finishing. First the whole top is cut down level with No. 0 paper, the linoleum-covered block being used to sand in straight, back-and-forth lines. Avoid any crosswise or circular sanding. A dry floor-scrubbing brush is useful for cleaning off the occasional spots of glaze which will appear on the sandpaper after use. If left, these may cause serious scratches.

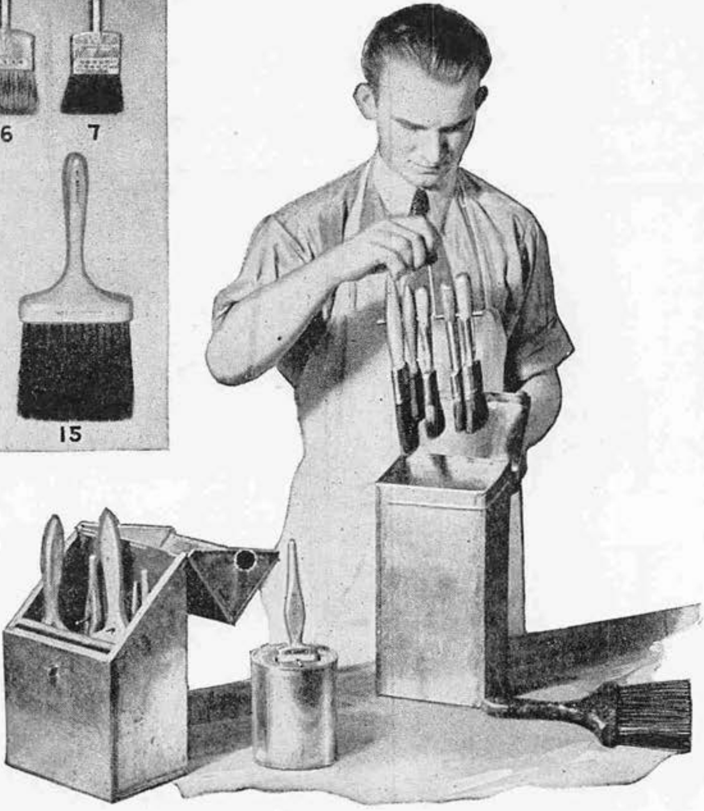
Few amateurs inspect their sanding properly, but this is a matter easily remedied after studying the photograph in which the sander has turned his back to the light so that he can see the inadequately sanded portions and mark them with chalk. What cannot be seen can sometimes be readily detected with the finger tips, which are passed lightly but thoroughly over the piece. It is at this stage that real finishing begins, and to omit any of the steps or to do them carelessly is to insure regrets thereafter. Above all, see to it that all sharp edges are rounded slightly—about as much as the round of the lead in an ordinary pencil. Edges so sanded with No. 3/0 paper retain the stain and finish and appear sharper than edges left sharp. Many a fine piece of good furniture has been ruined in use by having its edges wear white.

This particular table has a maple band molding on the edge and a crossband of ripple-figured black walnut surrounding a satinwood center. After the entire piece has been sanded with No. 0 garnet paper, the top is sponged with a clean cloth or sponge dipped in tepid water and wrung out practically dry. This should be used to dampen slightly all parts of the top, which should not be touched by the hands or dark spots will be certain to develop. Whenever the hands touch iron tools and later a damp wood containing tannic acid, as nearly all woods do, a form of ink stain then develops which must be bleached out.

Bleaching, where necessary, is done with any of the commercial solutions used to bleach laundry clothes and can be had at most groceries in bottles. Apply this with a clean floor brush or a rubbing brush; do



1, 2, 3. Black China wall brushes, 3, 4, and 6 in. 4, 5. Ox-hair varnish brushes, 1½ and 4 in. 6. Pure badger varnish brush, 2½ in. 7. Fitch brush for varnish and shellac, 2 in. 8, 9, 10. Oval paintbrushes. 11. Curved handled rubbing brush. 12, 13. Black China paint and varnish brushes. 14, 15. Dusters



Not only must good brushes be bought, but they must also have the best of care. Brush keepers of commercial and homemade types are shown. The bristles should clear the bottom of the cans by at least an inch

not use a sponge or it will fall to pieces in your hand. Apply to a whole surface on the part affected rather than to the local spot, which may become enough lighter to be noticeable. All sponging and bleaching operations tend to raise the grain of the wood and lift up any bruises that may not have been seen or dents which may be submerged.

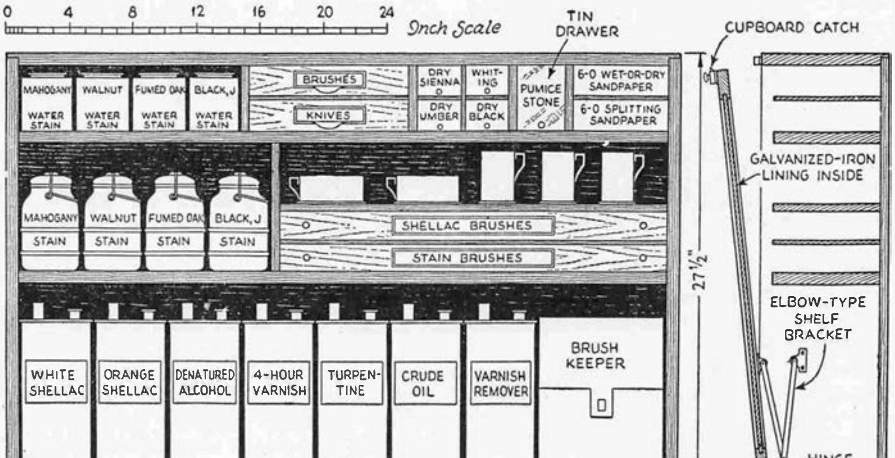
After it is dry, the piece is again sanded clean, true, and glass smooth with No. 3/0 or 5/0 garnet paper. Inspect particularly for any traces of cross grain or circular sanding scratches, which, if allowed to remain, are certain to appear beneath the finish. Whenever possible, use some form of pad or old blanket upon the bench top of to prevent denting or otherwise damaging the top.

Circular work, as the turned column and band-sawed feet of this table, should be cleaned up with the partly used papers left from the work on the top. Their previous use has made them more flexible and less sharp so that when their backs are slightly moistened, they adhere to the fingers and permit sanding the turned and rounded portions without cutting off bead or fillet details. Sponge, bleach out any spots, dry, and resand as for the top. Be very particular about taking out all traces of glue around the leg joints, since stain will not penetrate glue. Sometimes the only way to remove such traces is to use a rubbing brush and boiling hot water.

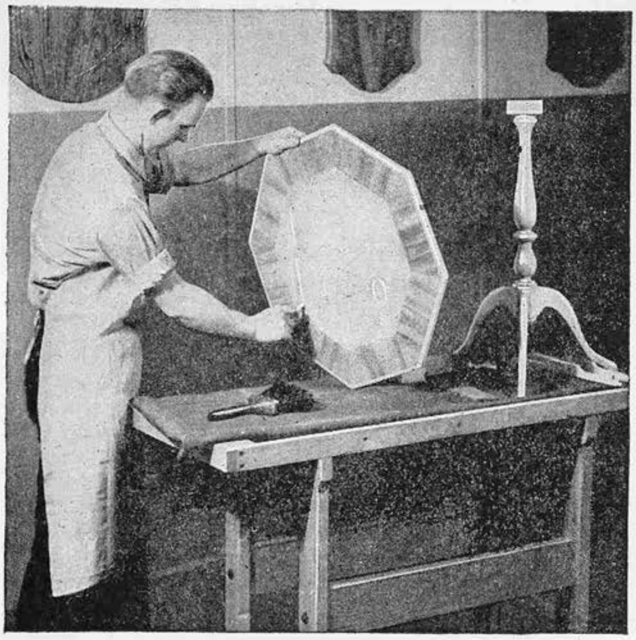
This sponging and resanding process overcomes the only possible objection to the use of water stains, the fact they do raise the grain. This, however, is a matter in their favor on quality work since the raising of the grain opens up the pores, lifts up dents to permit cutting them down to a permanent level, and generally cleans up the surface for the production of a fine transparent finish, not at all possible with other stain types. The small amount of time and labor needed for this extra sanding will soon be forgotten when the results are noted on the final inspection.

At this point a short discussion of the various stains is in order. Those which use pigments ground in oil and thinned with turpentine are not stains in any sense of the word, though often offered for this purpose. They are merely dilute paints and cannot be expected to give any but the coarsest of effects. Stain powders soluble in alcohol, while easy to make, are difficult to apply without innumerable streaks and patches; are easily lifted by subsequent finish materials, and worst of all, fade almost eighty percent. The so-called "penetrating stains" are not at all satisfactory, since it is difficult to reduce them for making lighter colors; they streak and lift badly when coated with shellac; they may even bleed through a number of coats; and, like the spirit stains, they fade about fifty-seven percent.

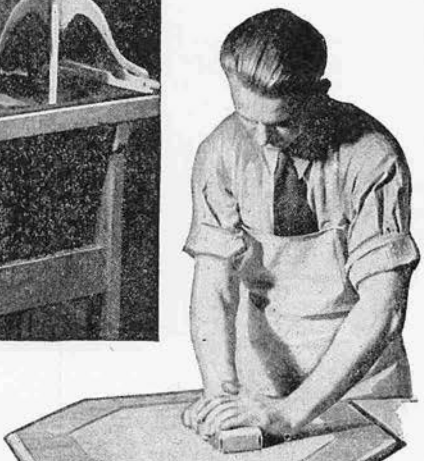
Water stains, on the other hand, overcome all these objections and at the present time can be purchased from various stain manufacturers in standard colors of standard concentration. Practically all woods can be stained and all the various shades matched readily if standard 4-oz. solutions of red, yellow, orange, and black are kept in gallon jugs ready for use. Stain powders of standard colors also can be bought by the pound or less, and 4 oz. of the dry color are dissolved in a gallon of hot water. This can be kept in a glass container and used as needed, so that the color will always be on hand for a future



A well-equipped home workshop should eventually have a collection of brushes like those shown at the top of the page and a wood-finishing cabinet with approximately the supplies indicated above



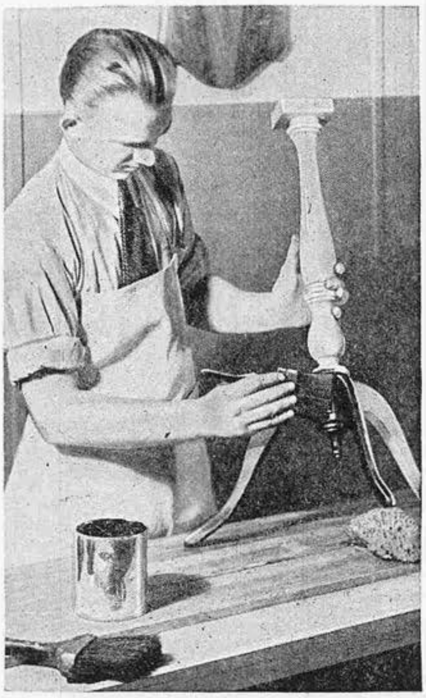
At left the table top is being inspected and all improperly sanded portions marked. Note angle at which the top is held in relation to the light. The actual sanding is done with quarter sheets of sandpaper folded over a block as illustrated in the photograph below



match on another new piece of furniture. The investment is small and the stain does not deteriorate under average storage conditions. It is even possible to use high-grade household package dyes of the type sold for dyeing silk. Get them in the colors named above and make up the solutions for your own match colors. For this it will be necessary to do some experimental work in order to get the right amounts of red, yellow, orange, and black to produce the correct shades on the woods you use.

In either case, for your own reference you should have a set of color matches made up on the woods which you use for making furniture. About 6 by 18 in. is a good size. These should be nicely sanded, then marked off into four sections each. Use the standard 4-oz. color solution on the first section, preferably the bottom. Wash out the brush in hot water, wipe dry, and use to apply the next color, which should be made from the 4-oz. solution reduced to the proportions of 3 oz. of color to a gallon of water. Measure accurately and repeat for each section, reducing each solution as required. This then will give you four solutions and four shades from light to dark. When the match panels are finished with varnish and rubbed, as will be explained in articles to follow, they will provide an adequate guide for getting out colors suited to your new cabinetwork.

The stain should be applied preferably with a brush of the so-called "rubber-set" type, which has been previously used for some time in varnish. The bristles in such a brush are "satisfied" with varnish in that their internal structure is well filled with the material and hence will not absorb water from the stain solution. Before using such a brush in stain, it should be cleaned with varnish remover, then turpentine, then denatured alcohol, and finally in warm water and soapsuds to remove all traces of solvents. Such a brush should then be kept for water stains only and after use should be rinsed in hot water, slapped into shape against the side of the sink while being held bristles down, and then hung up to dry. Afterwards it should be laid away in the storage cupboard in such a manner that the bristles are not allowed to get out of shape.



Beginning to stain the table. Those parts least seen are always done first, and conspicuous parts last. Note how brush is held

As in the case of most mechanics who have learned to invest in high-grade tools for the production of quality work, so too have home workers realized the value as well as the necessity of buying good brushes and then taking care of them. First of all, deal with a firm that sells quality paint-shop supplies and has a reputation to maintain, for in the brush business, as in few others, there is no limit to which quality can be sacrificed and still make something that looks like a brush. Ask the salesman to recommend a brush the firm will guarantee to be of good quality and manufacture. Buy the "rubber-set" grade and avoid brushes with cheaper "fillers." Ask for an all-bristle brush free of "butt stocks," as they are known in the trade. A real bristle consists of the butt, stalk, and the flag or tip, so called because in first quality bristles it is split naturally and is of prime importance in doing good work. With the less expensive bristle or cheaper grades of brushes, a few tips with good flags will be used around the outside of the brush while a mixture of lower grade bristles, or even butts cut from stock too long to be practical for some other brush, will be used to make up the weight and bulk of the brush.

For average use in both home and shop, an XXX black China bristle, full-chisel, varnish-flowing brush, either flat or oval, is considered practical. For turned work, as chair and table legs, where the stroke is around the leg rather than lengthwise, a single-thick, varnish-flowing type of fitch, bear, or oxhair brush is to be preferred. Brushes come in single, double, and triple-thick ferrules, depending on the size and use to which they are to be put.

For wide surfaces, as table tops, it is advisable to have at least one 3-or 4-in. brush of a good quality grade. Small brushes do not cover the work fast enough to be practical with modern quick-setting finishes.

The purchase of quality brushes demands good "keepers." Two types are illustrated, one which can be designed by the home worker himself once the principles are understood; and the other type can be revamped from vegetable cans which have been cut open with a rotary can opener. In each case the brush must be suspended in such a manner as to have the bristles at least an inch above the can bottom.

You have perhaps been told emphatically that a varnish brush should be washed out in turpentine after use and then set away on the shelf because the bristles will

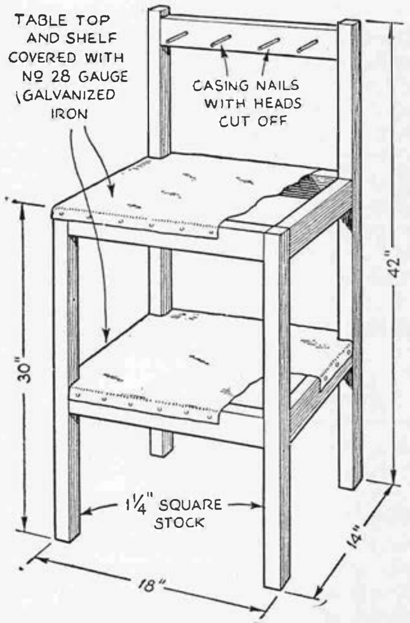


TABLE TOP AND SHELF COVERED WITH Nº 28 GAUGE GALVANIZED IRON
CASING NAILS WITH HEADS CUT OFF
42"
30"
1¼" SQUARE STOCK
14"
18"

This light, convenient paint-shop stand is a genuine labor saver and well worth making be injured if it is preserved in a liquid keeper. The fact is, however, that under modern conditions, when nearly all varnishes are of some form of the four-hour type, oxidation of the traces of varnish which remain in a brush, even after it has been carefully cleaned, takes place very rapidly and the brush will become partially "seedy," as the brush hand calls it. A brush "keeper," properly built and kept clean, will preserve the brush in perfect shape. Examples are brushes that have been under test in keepers for twenty years. Two have white Russian bristles and for spreading enamel today are priceless. Another has spread color varnish on over 500 cars, and while worn down about ½ in. is still a much prized brush for many kinds of difficult work on broad surfaces.

New varnish brushes should be dry cleaned with the fingers and some form of dry duster like a new scrubbing brush; washed well with turpentine, and then suspended in a mixture of half slow-drying varnish and half pure turpentine. Kept in this manner, they are in ideal condition for the application of finishing materials. The turpentine-varnish mixture should be kept at a level halfway up on the metal ferrule of the brush so that any traces of hardening of varnish may not take place on the brush itself and then be worked off into the new finish coat.

At no time should a good brush of any type be suspended in water, for to do so will cause the bristles to get soft and flabby with entire loss of springiness, and in addition may so swell the plug in the base of the ferrule as to split the latter and ruin the brush.

Paintbrushes may be kept suspended in a mixture of turpentine and raw linseed oil, although the best medium in which to store them continuously, it is found, is either pure pine oil or half pine oil and half raw linseed oil. Shellac brushes should be washed out with denatured alcohol and then laid away on the shelf until needed.

Sometimes brushes left on the shelf get hard because of careless cleaning. Do not try to soften them by bending with the fingers; to do so will break a number of bristles, and these which will work into the new coating of finish and cause a lot of trouble. Soften the brush in either turpentine or alcohol, depending on what the brush was used in the last time.

Make up your mind to buy good brushes and then take care of them. When you use them, remember the paint-shop rule for the order in which to finish the various surfaces of any project:

"Start with that which you see the least,
End with that which you see the most."

TOOL-MARKING FLUID CONTAINS NO ACID

THE simplest tool-marking fluid that contains no acid can be made by dissolving 12 grams of copper sulphate crystals and 10 grams of salt in 40 c.c. of water, or approximately a teaspoonful of each of the chemicals in 2 oz. of water. The fluid is applied to the metal by means of a wooden stick, a pointed brush, or a sliver of quill from a feather.

DAMP-PROOFING CELLAR WALLS IN COLOR

DAMP cellar walls, aside from being unhealthy, prevent the use of the basement for much else than a catchall for dust and an accumulation of old furniture, boxes, and rusted gardening tools. This condition, however, can be remedied in many cases merely by the application of a good grade of cement paint.

These cement paints, which should not be confused with either cold water or kalsomine paints, can be obtained in a variety of colors—cream, grey, green, blue, and white—and when properly applied will form a protective covering for the walls that will convert your cellar into an additional room—a workshop, smoking or billiard room, a playroom, or a room for a thousand and one other uses.

The surface to which the paint is applied must be free of dirt, white spots caused by efflorescence, and previous coats of cold water paint, kalsomine, and whitewash. If the surface is of some nonabsorbent type, cement paint should not be used.

After the surface has been thoroughly cleaned, wet it down and apply the first coat of paint, made by mixing the cement paint powder with water to the proportions suggested on the package.

The second coat is applied after the first coat has dried for twenty-four hours and has been thoroughly wetted with water. The second coat, as in oil paints, is thicker than the first and is made by decreasing the proportion of water to a given amount of the paint powder.

Apply the mixture with long strokes of the brush, keeping plenty of paint on the bristles at all times. A spray also can be used, if desired. In both cases, however, the paint should not be allowed to settle in the paint container but should be agitated frequently.

A thick paste, which can be made from the paint powder, will serve for filling any cracks in the surface.

Cement paints also can be used effectively on cement garden furniture, exterior walls, and swimming pools. Another popular use is for waterproofing and improving the appearance of old and discolored brick foundation walls.

HOW TO GET

A Fine Finish on Poor Wood

WITH GLAZING PUTTY

AFTER sandpapering some wooden surfaces as much as possible, you often will still find, especially on the poorer grades of lumber, certain rough areas that are too deep to be made smooth. These are usually the areas around knots where the end wood fibres are short and run in various directions. Even a plane will not smooth their roughness. In such cases we can follow the example of the old-time carriage painter and apply thin putty with a broad glazing knife—a knife which is about three times as wide as a putty knife and has a somewhat more flexible blade.

Sandpaper should be first used to make the surface as smooth as possible—No. 1 sandpaper, followed by either No. ½ or No. 0. Next a white lead paste is mixed with boiled linseed oil and turpentine in equal parts and tinted as desired with colors ground in oil. This paint is applied and allowed to dry overnight or longer. Then you are ready to glaze-putty.

The putty is made from white lead-in-oil paste, to which enough dry whiting is added to make a stiff, plastic mass. Beat the putty with a wooden mallet or club until it is soft and well mixed. Take a little japan drier and boiled linseed oil in equal parts and add them to the putty together with enough additional whiting to keep the mixture about as thick as butter.

Apply the putty over the surface with the glazing knife and rub it well into all holes, dents, and gouge marks. Scrape off the excess putty and allow the surface to dry hard. Usually in a day or two it will be hard enough to be sandpapered to a level, smooth surface. If you were careful not to leave tool marks in the putty when scraping away the surface, not much sandpapering will be necessary.

Another glazing putty that will dry very hard and can be rubbed down smoothly with pumice stone and water on a felt pad is mixed from white lead-in-oil paste, dry whiting, and fine, dry pumice stone. grade FF, thinned a little with floor varnish and japan gold size or drier.

By using either of these glazes on furniture, cabinets, or interior trim, you can make cheap lumber take practically as fine a painted finish as the very best wood. The glaze coat forms a fine ground for paint, enamel, or lacquer, especially as the putty may be tinted with dry colors to match the finishing color which is to be used.

A putty mixed from white lead-in-oil paste, dry whiting, and a little floor varnish also can be used for filling dents in thin metal surfaces after the first coat of paint has been applied. It is, however, often better to hammer the dents out as smoothly as possible with a wooden mallet, if you are able to get at both sides of the metal, and then fill them with solder. The metal must be cleaned perfectly bright with emery cloth or sandpaper and a knife. Then apply solder until the dent is a little more than full, and afterward file the solder flush with the surface.

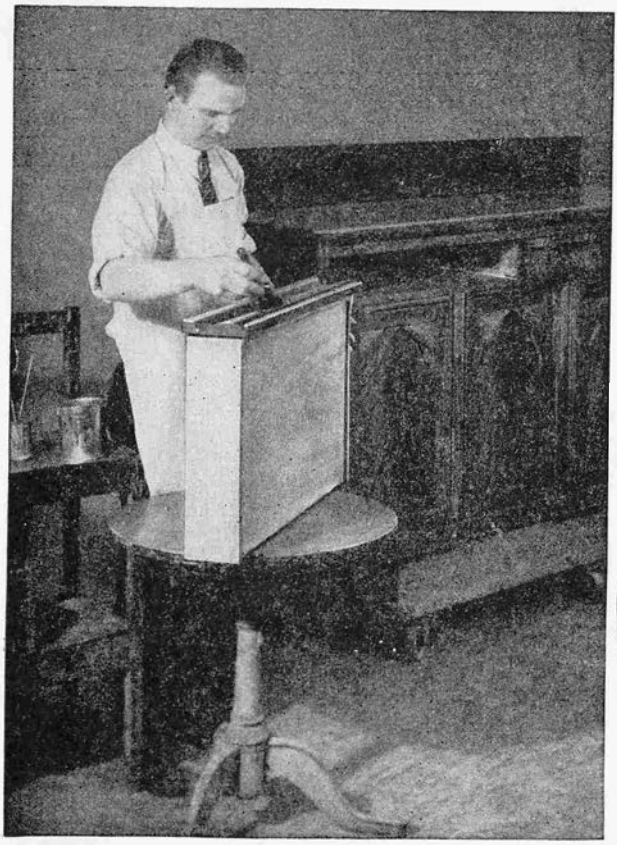
In puttying new wood, the first requirement is that the wood be first given one coat of paint. For exterior surfaces a good putty can be made by mixing dry whiting with pure linseed oil, but a still better putty is made from white lead-in-oil and dry whiting. If it becomes too stiff, add a little linseed oil.

For interior wood surfaces a good putty can be mixed from any oil paint, white lead, or flat wall paint simply by adding enough dry whiting to make a plastic mass. Knead it well with your fingers and tint it with dry colors. This type of putty can also be used for woods which are to have a natural or stained finish, but it is best to mix the putty a shade darker than the natural or stained wood because the general color of the finish will ordinarily become a little darker with age.

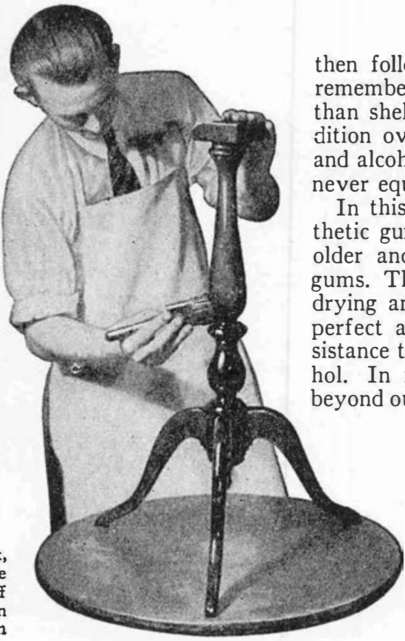
THE FOUNDATION OF GOOD

Furniture Finishing

. . . SEALERS AND FILLERS



Applying the sealer coat. The brush is held at an angle, and strokes are made from center towards each end. Note swivel stand



On turned work, stroke around the column. Tip off the long portion gently up and down

MANY a heated argument has been started at home workshop club meetings over the question of what kind of sealer coat or undercoater should be used in finishing fine handmade furniture. Should it be shellac or varnish?

Before attempting to settle this question, it is necessary to consider just what is required to obtain a really good finish on furniture or other cabinetwork. In general, three steps are necessary:

1. A staining process.
2. A sealing or undercoating process, which includes the filling of the grain in all but very close-grained woods.
3. A bodying-coat process.

The use of staining materials has been completely discussed on the preceding pages of this book. The second process leads us at once into the field of argumentative discussion of the merits of shellac and varnish.

Shellac is a gum dissolved in a special grade of denatured alcohol, which, when applied to a surface and allowed to dry, hardens by the loss of the solvent (alcohol) alone. This is a purely mechanical process in which the wet film hardens and loses weight.

Varnish is today made of synthetic gums, melted with heat and combined with drying oils such as linseed or tung. Drying agents are added, and the varnish is reduced to a working or brushing consistency with turpentine or a similar type of solvent. When such a material is applied to a surface, it hardens partly by loss of the turpentine, partly by absorption of oxygen from the air, and changes from a liquid to a solid film by a chemical process. The final product is neither physically nor chemically similar to the material in the can and has actually gained in weight during the change from liquid to solid.

It is therefore evident that the two systems are fundamentally opposed to each other. While expediency frequently demands their combination, yet no real affinity exists between a coat of varnish and a coat of shellac when the latter is used as an undercoater. If you use shellac at all, use it throughout the entire schedule from start to finish. Remember, however, that it will have only fair resistance to wear, very little resistance to water, and none at all to alcohol (liquors or perfumes).

If varnish is to be used, as it should be, then follow a complete varnish schedule, remembering that it will do much more than shellac can mechanically and in addition overcomes wear and resists water and alcohols in a manner that shellacs can never equal.

In this day of modern chemistry, synthetic gums and resins have replaced the older and less desirable forms of fossil gums. The new varnish products are fast drying and clean sanding, and they give perfect adhesion between coats, high resistance to wear, water, sunlight, and alcohol. In fact, they are so fine as to be beyond our dreams of but a few years past.

After staining a piece of furniture, we are confronted with the necessity of protecting the color against subsequent operations. If no sealer is used, the filler may easily discolor a clear and delicate stain coat, because of the absorption of oil and fine pigment around the pore areas. To overcome this, shellac may be used in a shellac schedule or varnish in a varnish schedule. In either case the sealer coat must be greatly reduced in body.

For shellac sealer, use what is called standard “four-pound cut” as it comes

The filler must be brushed in quickly but thoroughly. The young man at right is cleaning moldings with a picking stick and cloth from the can in the proportion of one part of pure shellac to four or even five parts of denatured alcohol. Do not use any form of wood alcohol, the fumes of which may easily cause partial or even permanent blindness in the case of susceptible persons. Do not use motor anti-freeze alcohols, since they frequently contain kerosene or pyridine, in which case the shellac coatings will never dry hard enough to sand. Such a reduced coating material will practically disappear into the wood, but is sufficient to seal the unsanded stain coat, and when dry and hard will permit stiffened wood, fuzz, or "whiskers" to be cut down fast and clean with a 6/0 finishing garnet paper without graying the finish, since the color has been driven through the "whiskers" by the sealer.

IF VARNISH is to be used, then the best type of so-called "four-hour floor varnish" should be purchased. This should be reduced with turpentine in the proportion of one part of varnish to two parts of turpentine. Like the shellac, this should be applied over the unsanded but well-dried stain coat and completely brushed out. To dry this coating will require from four to six hours at 75 to 80 deg. F.—much longer than shellac, to be sure. Unlike the latter, however, it will not scratch white when the finish schedule is complete and offers a perfect adhesion to subsequent coats of the same stock applied later. Do not use the grades of varnish known as "cabinet rubbing" because they lack the durability and toughness characteristic of properly made floor varnishes; and in the case of good furniture, toughness and durability over a period of years are the most desirable requisites of a fine finish.

For the application of the sealer, long practice has shown that single-thick, varnish-flowing fitch or oxhair brushes are best suited, since their fine but reasonably stiff bristles lay on just the right amount. They are free from certain objections attending the use of the stiffer and longer bristled XXX black china general-purpose brush. Most amateur craftsmen have come to realize that good cabinetwork cannot be turned out with poor tools. Fully as important, then, is the need of the proper type of high-grade brush, well cared for, in the production of a first-class finish.

Study the illustrations for the correct method of holding the brush, with the fingers down to, or even on, the ferrule. On turned work, stroke around the part, slightly bending the bristle tips, and avoid excess strokes that tend to make the coat foam or bubble. A final stroke lengthwise may be made lightly to tip off the work. Keep the room temperature about 75 deg. F.

WHEN either type of undercoater or sealer has been well dried and carefully sanded with a 6/0 garnet finishing paper slightly moistened with water on the paper back, the piece is ready for the operation of filling. The tip-table top illustrated on the preceding pages has a center of fine, golden-colored satinwood surrounded by ripple-figured walnut; it therefore requires two different colored fillers—golden toned and deep chocolate brown. The correct method of filling the top will now be described.

Fillers perform two fundamental functions: first, to level up the pores with the surrounding surface of the wood; second, to produce a color effect that, when properly applied, tones and clears up the entire piece of furniture.

Fillers must be made on a nonshrinking, transparent, and hard base material, known in the trade and obtainable commercially as "silex." This is essentially quartz, powdered so fine that it will float on water and yet retain its needlelike or crystalline shape. When used as the principal ingredient of filler, it locks itself into the pores and does not shrink loose as did old-fashioned starch fillers.

For those who want to prepare their own filler base and stock fillers, the following should be made up in 5-lb. lots and kept sealed in a tight can until used: 10 oz. boiled linseed oil; 2 oz. floor varnish, 4-hr. type; 2 oz. turpentine Japan drier; 4 oz. pure turps. Stir well and gradually add 5 lb. silex, kneading with the hands or stiff paddle to form a puttylike dough. This is the so-called "natural" or uncolored filler base.

For birch, cherry, gum, or similar woods, use 6 lb. of this paste per gallon of thinner. For oaks, mahoganies, or walnut, use 12 lb. of paste. For Philippine mahoganies or lauans, ash, chestnut, or similar coarse-grained woods, use 15 or even 18 lb. of paste per gallon of thinner.

THE most practical thinner thus far developed consists of one part pure turpentine and two parts standard grade gasoline (no ethyl). The turpentine keeps the oils, varnishes, and driers in liquid condition, while the gasoline forms a cheap thinner, which evaporates fast enough to be practical in use.

Weigh out the paste base, place in a large enough can for mixing, and reduce with the correct amount of thinner. To color the base filler to the golden tone required for satinwood, use French ocher, golden shade, ground in oil and sold in 1-lb. cans. About 1 lb. is required per gallon of completed filler.

For the brown to be used on walnut, use burnt umber with a little Van Dyke brown if a darker shade is needed. Generally 1 lb. of color, ground in oil, will readily color 1 gal. of ready-to-use filler base.

For filling the following are required: an old, stubby brush, well cleaned out; several pieces of clean burlap cut about 12 in. square; some clean rags free of buttons of snaps; and a picking stick made of a ½ by 6-in. wood dowel sharpened to a pencil point at one end and a flat skew-chisel edge at the other.

First, the golden filler is well stirred and brushed on freely over the satinwood center of the table top. Care must be taken not to get any on the walnut. This is allowed to become set or lose its turpentine shine and is then padded in with a piece of clean burlap folded into a pad and used in a circular motion to insure pressing the filler mass into all parts and crevices of the surface. Following this operation, clean rags are used to remove all surplus stock, working *across the grain* constantly. Inspect the work carefully *against the light* to see that all pores have been leveled up.

The brush is now quickly cleaned out in a little gasoline, snapped dry by swinging sharply at arm's length towards the floor, and then dipped into the well-stirred brown filler and applied over the walnut portions. Brush on *with the grain;* let set slightly; pad in vigorously with a circular motion, and clean off *across the grain* before the filler begins to dry or rub hard. Speed in filling is most important.

CLEAN up the work with a fresh cloth. Run the picking stick around all molding and fillet lines to free them of all traces of left-over filler. Dust off lightly but thoroughly with a round or flat duster, and with a clean pad of cloth remove every trace of finger marks or smudges of filler.

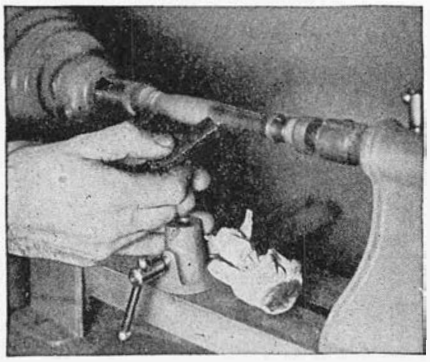
Any traces of filler left to harden offer the same resistance to sanding as would a concrete floor. Should any filler be left by accident until it has had time to harden, remove it most carefully with 6/0 garnet finishing paper and gasoline. Great care will be necessary to avoid sanding through the sealer and stain coat. If some portion is sanded too much, a small cloth pad wet with stain must be passed lightly but equally over that part of the surface and allowed to dry.

Set the filled work aside to dry in a room kept at 70 or 75 deg. F. for twenty-four hours. Improperly or insufficiently dried filler coats can cause much trouble during later finishing operations.

FLAP OF WALL PAPER CONCEALS OLD NAIL HOLE IN PLASTER

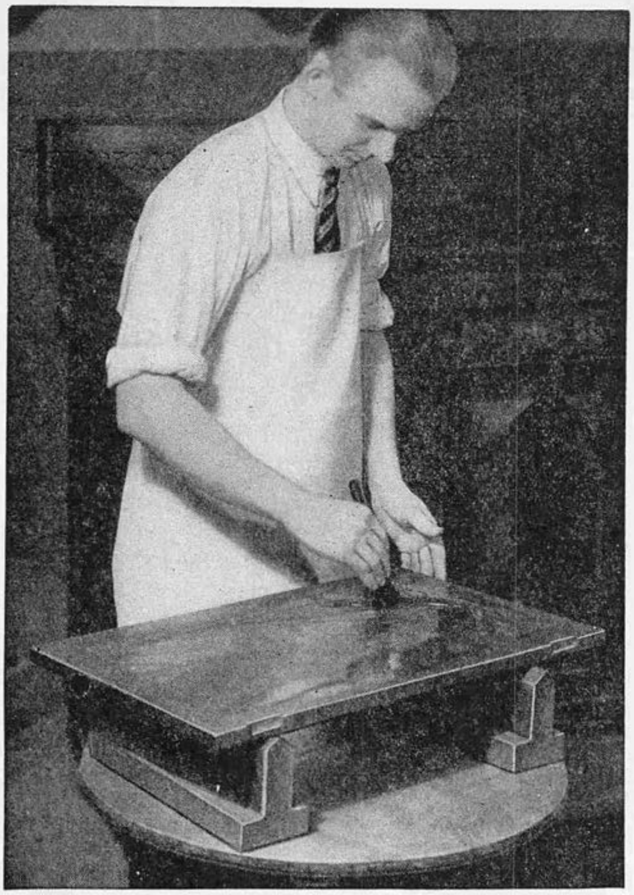
WHEN it is necessary to drive nails or screws into walls covered with wall paper in order to hang up picture frames, first cut a small triangle in the paper at the point where the hole is to be made and dampen the spot. Then pull the flap away from the wall and bend it down. If it is desired to remove the nail or screw later on, the paper can be bent back and pasted.

TURNED WORK COLORED WITH SEALING WAX



MANUFACTURERS of art objects in India sometimes produce a pleasing finish on turned articles by applying thin coats of sealing wax of appropriate colors. This has been termed "lac finishing."

Finish the article by sanding, after turning operations have been completed; then hold sealing wax against the parts to be colored and operate the lathe at high speed. Friction between the wax and the wood will melt the former, causing it to flow out in a thin layer. Often this layer is irregular, but it can be smoothed out by holding a cloth pad against the surface until the coating becomes plastic. Use as small a cloth as practicable and be careful not to let it wrap around the work.



TRICKS OF THE TRADE IN

Varnishing Furniture

Varnishing the panel of a sideboard door. Stroke from the top of the panel around and halfway down the side, then from the bottom corner and halfway back. *Right:* Freshly varnished chair. Do the legs and frame first, then the head and center panels

IN WOOD finishing—as, indeed, in all painting—there is nothing that so completely distinguishes the amateur from the professional as the manner in which he handles his brush.

All standard brushes have three portions: the bristles; the ferrule, which shapes and holds the bristles in permanent form; and the handle, of various shapes, which adds balance to the whole assembly and at the same time enables the brush hand to use the tool correctly and in a practical manner. Before reading any further, study the accompanying photos and note particularly the method of holding the brush.

Do not grasp the brush awkwardly by the handle, as so many beginners are apt to do. Fundamentally, all small brushwork, and much of the larger types as well, is done almost entirely with a short, quick, and easy flection of the wrist. There is scarcely any noticeable arm movement. Hence, grasping the brush by the handle defeats the primary method of brushing—working with a maximum of free wrist movements. Grasped as shown, *well down on the ferrule,* a brush is handled quickly and dexterously. In addition, the weight of the handle contributes a sense of easy balance, which cannot be obtained otherwise.

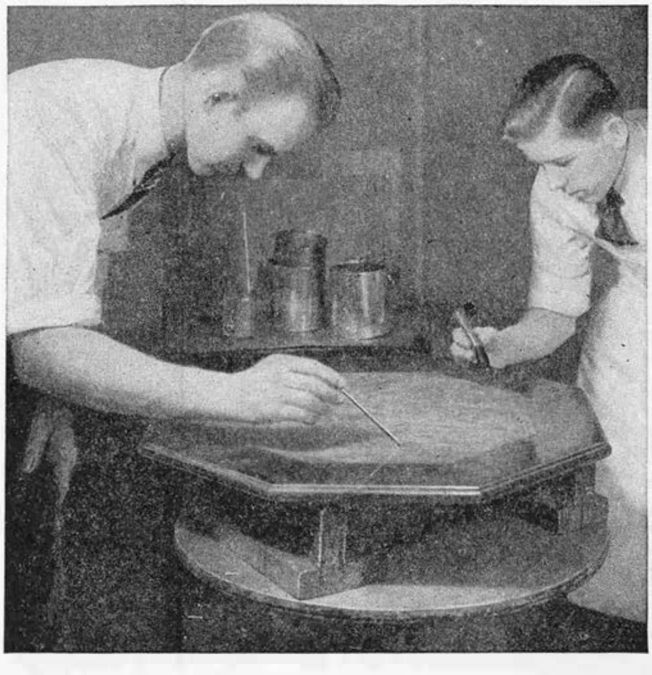
Next in importance is the method of stroking, which, if correctly applied in the beginning, soon becomes automatic. So many men, and women too, press the brush hard enough to distort the bristles, a practice which, if long continued, will produce a "fishtail" brush, the inevitable sign of the inexpert brush hand. A good varnisher knows that he must handle his brush in such a manner that the brush constantly tends to keep its full-chisel, varnish-flowing shape, enabling the material to flow out naturally from the undistorted bristles; while the brush handle, at a varying but generally low angle, definitely points in the direction of the stroke.

In many cases, during the quick and easy brush strokes used in working out a freshly varnished surface, the bristles are bent only a little; and when a panel is tipped off with long, easy strokes from ends to center where the brush is lifted off entirely to "feather" the stroke, the bristle tips alone are used and do not bend at all. This allows the brush actually to float on the tips of the bristles, performing that expert touch which "brings up" the newly applied varnish to a fine gloss, free of brush marks and bubbles, in a manner almost impossible otherwise. It also means fast, clean, sure work so that the varnish may still have time to flow out before it "sets" or stops leveling itself, as it is designed to do.

Again, in running panel lines and moldings, a certain technique is in order. In varnishing a door panel of a mahogany sideboard as illustrated, the stroke is first run around the panel to coat the panel margins thoroughly, and then the panel itself is quickly cut in until completely covered. This is done with an absolute minimum of strokes and frequent pauses to wipe the sides of the brush quickly and lightly on the strike wire of the varnish pot to remove any bubbles, before again tipping off the panel for that last expert touch which leaves it a thing of lasting beauty.

Next, the top and bottom cross rails of the door are cut in; followed by the hinge and lock stiles, on which long, running strokes leave a clean-cut appearance, free of cross lines from improper brushing.

The door edges are covered by "spatting" the sides of the brush against the



How the picking stick is used to remove a dust speck from the freshly varnished table top; and, at right, cutting in the half-round edge molding with the bristle tips, working from center to ends of each segment edge of the door, while the entire brush is held vertical for backstroking the work. A running stroke with the ends of the bristles would almost inevitably cause the brush to split, and the bristles would then mar the freshly varnished face portions of of the door frame.

As soon as the unit surface, as a door, drawer front, end panel, or top, is completely varnished, it should be "picked," especially under home workshop conditions, in order to remove traces of lint or other foreign material which will occasionally find their way into even the cleanest of brushed jobs.

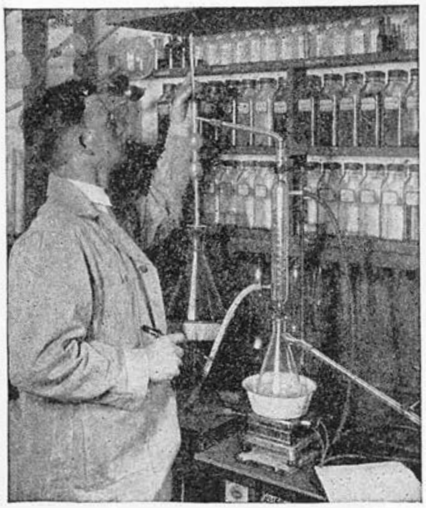
For avoiding this dirt as far as possible, two methods are available: When the work is freshly dusted off, just previous to varnishing, it is then very carefully and thoroughly gone over with a commercial "tack rag." Follow the manufacturer's directions as to the use and care of this prepared cloth, which removes and holds dust, lint, or other particles left by the duster. The use of a tack rag is definitely one of the tricks of the trade in the production of fine, clean work. Sprinkle the rag lightly with water from time to time and keep it rolled up in a piece of clean oilcloth or it will soon become worthless and hard. This is most important and should not be neglected even a minute or two.

The second and final step is also a trick of the trade. For this operation get a No. 3 or 5 artist's brush with a long handle and with a tiny point of bristles about the size of the lead tip of a freshly sharpened pencil. Place the bristles of the brush between the lips, moisten slightly, and then withdraw in such a manner as to leave the bristles in a fine, close point, which is then used to slip under and lightly lift out traces of lint.

For the beginner, it is sometimes difficult to distinguish between transparent dirt and bubbles of the same size and shape. The bubbles, however, can be easily recognized because each will have a tiny "pearl" on top caused by the refraction of the light, whereas the dirt speck will appear the same throughout. Leave the "pearls" alone for if not too numerous they will all flow out, but take great care to lift out dirt and lint specks before the varnish begins to set.

Another method of doing this same work, much in vogue with varnishers who feel that the varnish flows back better if picked with a ball of so-called "burnt varnish," consists of "cooking" one part of varnish and seven or eight parts of ordinary brown rosin in a small tin can placed in a larger one containing boiling water. During the process, stir constantly with a wooden paddle or dowel rod until the mixture is well blended; then remove a drop and let it fall on a piece of glass. If sufficiently cooked it should form a pill stiff enough to allow molding into a ball of shoe-button size when worked on finger tips moistened with saliva. This ball should not be over 3/16 in. in diameter. Place it on the end of an applicator, one of those wooden rods about as large as the lead in a pencil used by doctors to apply cotton swabs in throat and nose examinations.

The prepared ball is held over the speck of lint, touched to it, and then quickly lifted off. It generally takes the lint with it and allows the still wet varnish to flow back into the hole in the film. In case the ball fails to lift the lint or dirt the first time, tap it lightly against the heel of the hand to make the burnt varnish sticky again, and once more touch the lint or dust speck. Once in a great while, a piece of lint becomes caught on a panel and cannot be removed. Leave it alone with the assurance that if the work is well dried and properly sanded or rubbed, it will not "pull out."


Testing various ingredients used in varnish. For good work, it is essential that amateurs use nothing but the best finishing materials

One of the hardest problems in dust and dirt control, it may be added parenthetically, is solved by sensible and adequate housekeeping. Have some quiet place prepared ten hours ahead of time and cleaned with a damp cloth and mop. See that the windows are tight and are left locked. Do not allow anyone to enter the room before you use it, and do not take visitors in to see your work during the drying period. Do not go in yourself if you can avoid it.

It is best, if possible, to set aside a small room, at least temporarily; keep it clean; wipe the walls; wipe the window sills and frames; mop the floor; put weather strip across the door bottom if necessary. Wipe off all table and stand equipment taken into the room, and keep yourself as dust free as possible. This means that you should dampen your hair with a wet comb; wear the crown of an old felt hat with the brim removed; take off your long-sleeved cotton shirt and substitute an old one with the sleeves cut off and hemmed, or wear a gym shirt. If you wash your arms before going to work, there will be little chance that they will shed any lint.

After you have used the picking stick, under no circumstances must you rebrush the surface in case the hole does not fill up by having the varnish flow back into place. You have simply been too slow in your brushwork, and the varnish has set. To brush it again with fresh material would only result in a detestable condition known as "piling up."

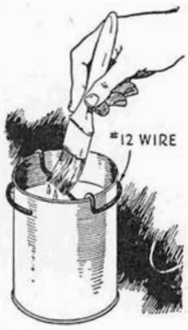
Good brushing practice is aided by a few simple pieces of equipment. A paint stand with metal top and bottom shelves like the one shown on a preceding page should be made. The design was developed through years of study and constant use in the trade.

Two of the accompanying photos show the work supported on a stand with a revolving top. It was made from a broken piece of drawing equipment. An old washing machine or dress form found in a junk yard or second-hand shop might furnish a similar tripod base for such a stand. Fitted with two or three sizes of metal-covered wooden tops, such equipment helps to turn out fine work under better working conditions.

Last of all, see to it that the brushes are kept in clean containers; that their bristles are clear of the bottom; and that the level of the liquid is always up on the ferrule, so that partial hardening of the varnish cannot make a "seedy" brush. A brush keeper like the ones shown on page 174 will keep the brushes in good shape.

REMOVABLE BRUSH WIPER SNAPS ON PAINT CAN

A wire bent as shown in the accompanying illustration and placed on a paint or varnish can enables one to remove surplus paint or varnish from the brush without spattering it or letting it run down the outside of the can, as is often the case when the brush is cleaned on the top edge of the container. This device, which may be easily removed from one can and placed on another of the same size, is especially valuable where inside work is being done.

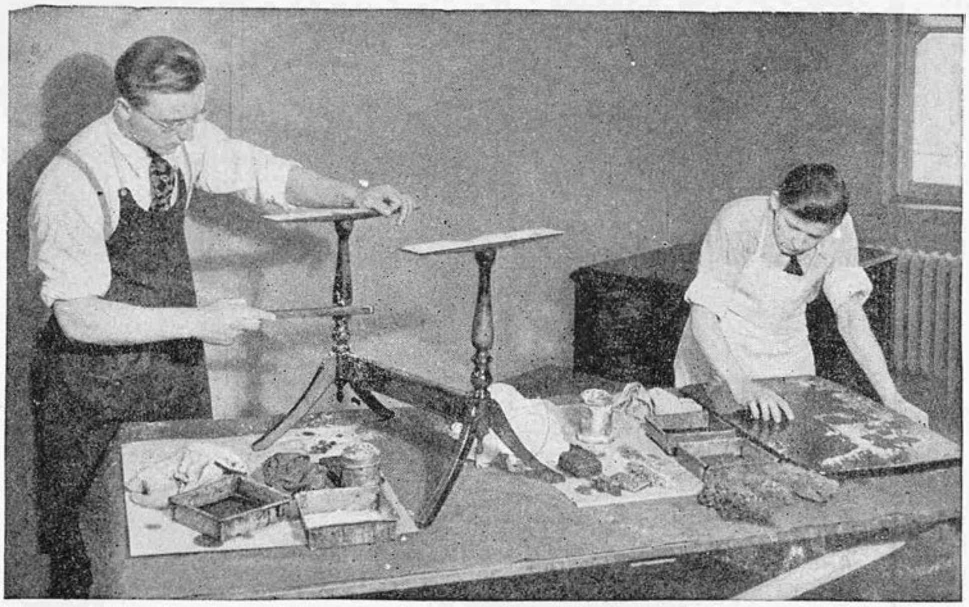


PLATING INNER SURFACE OF BRASS BOWLS

There is so much popular interest in hammered and spun copper or brass bowls that it is of value to know how the inside surfaces of such bowls may be easily plated with a low fusion metal such as tin or pewter. This type of plating gives a pleasing contrast in color, and at the same time renders the bowls more suitable for bonbon containers. It cannot, however, be used to plate an article that contains soft soldered joints.

Remove all tarnish from the surface to be plated by scouring it with steel wool. After the surface is thoroughly cleaned, slightly heat the bowl and smear the inside with paste soldering flux. Then place a few scraps of pure tin or high-grade pewter in the bowl, and continue the heating. As soon as the plating metal melts in the bottom of the container, use a pair of tongs to move the container around in such a manner that the plate will be distributed over the surface. A wooden stick will be useful in pushing the molten metal out to the edge of the bowl. Care should be exercised to avoid tinning the outside of the bowl.

After the surface is completely covered, throw out the excess metal, and wipe the plated surface while still hot with a clean cloth. This procedure will remove all dirt and any excess material that has remained in the bowl, and at the same time give the surface a polished appearance.

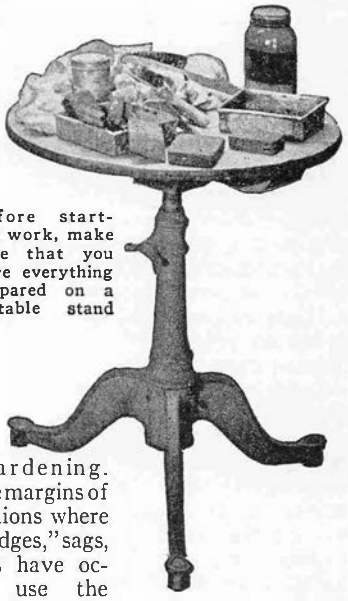


Pads and other materials should be placed on sheets of paper to protect them from grit. The worker on the left is using a rubbing brush for hard-to-get-at places while the other one is rubbing the table top

How to rub down the final varnish coat until it is like plate glass in depth and smoothness

A Satin Finish

FOR YOUR FURNITURE



Before starting work, make sure that you have everything prepared on a suitable stand

WHEN a piece of furniture or other woodwork has been stained, filled, and varnished as already described on the preceding pages of this book, it is ready to be rubbed down to a beautifully level and soft-sheened surface resembling plate glass in depth.

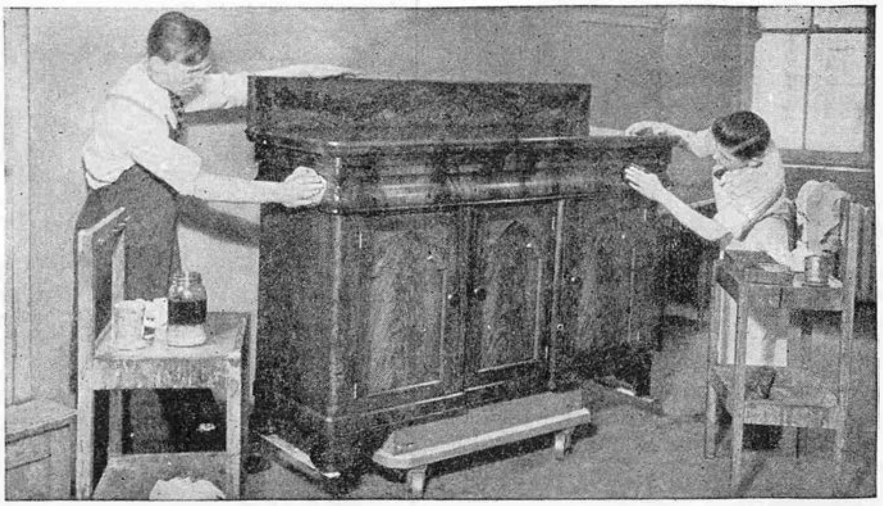
It is unwise to attempt the final rub-out with less than three coats of well-dried varnish on the work. Even with so-called "four-hour" varnishes it is best for amateurs to allow a week between successive coatings. Practically all failures in varnish films are the result of malpractice in this respect.

We have learned that a dry, single thick 6/0 garnet paper should be used for rubbing the first coat, and a water-wet 6/0 or 8/0 finishing paper of the so-called "wet-or-dry" type on the second and possibly in part on the third or last coat. This last-mentioned paper is fast cutting, and when "backed-up" by a 1-in. rubbing felt will do much to level all parts of the varnish surface previous to the last coat, which should flow out absolutely level.

Each speck of dust or lint causes the varnish to pile up into a tiny mound or ridge above the general surface of the film, two to three times as thick as normal. When the body of the varnish is perfectly dry and hard throughout, the "nib," as it is known in the rubbing shop, is only surface hardened. If such a surface is rubbed with pumic stone and water or oil, the pad and pumice cut off the top of the nib, and the soft core pulls out and adheres to the pad as a tiny glazed spot; and when the surface is washed off and dried. the varnish appears to be pricked with pinholes here and there. This is what the practiced rubber calls "pull-outs." If such a surface had been lightly water rubbed and redried several days more, the chances are that no pull-outs would have occurred. Hence it is important to allow at least a week between coats in a room 75 deg. F; and if not impatient, allow ten days for the last coat. The surface will be easier to rub, and the sheen will be far richer.

In testing for adequate drying, the experienced rubber will press the pad of his thumb carefully but firmly against any doubtful hardened portions, withdraw, and then wipe the surface to remove the thumb-oil print so that he can determine whether or not the warmth and pressure have left a noticeable thumb mark in the gloss of the varnish. If such is the case, more time must be allowed for drying and hardening.

On the margins of any portions where "fatty edges," sags, or drips have occurred, use the thumb or thumb-nail test to determine the actual hardness of the material. If a print is produced by either method, give the varnish more time for drying. Fairly hard sags or fatty edges may be partly cut down for further drying by using 6/0 wet-or-dry paper and lubricating the sandpaper by first rubbing it on a bar of pure white soap. Use the side of the thumb fequently to squeeze off the water and soap over the sags by a quick sidewise stroke toward the body. This stroke will expose



An old cotton flannel dipped in water, wrung out, and coated with polish is being used at the left for a final clean-up. The worker on the right is spot-rubbing where necessary after an inspection the surface in an almost dry condition for a quick inspection, which will prevent rubbing too far before setting aside for further hardening. Wash clean with a sponge and wipe with damp chamois.

IN ONE of the accompanying photographs is shown a rubbing table made from the base of an obsolete drafting stand. The present top is smoothly covered with heavy gauge galvanized iron and rotates for convenience, but can be clamped rigid if desired. Such equipment is invaluable in the home workshop. On the stand are placed the materials required for rubbing—a number of clean, old rags free of buttons or snaps; one or two rubbing brushes of different sizes; rubbing felts of various sizes and thickness; and two shallow pans like cake tins to hold crude petroleum oil and FFF pumice stone (triple fine or triple floated). A bottle of polish for the final clean-up is the only other essential. Incidentally, a man's old felt hat with the brim and crown cut into various sizes and shapes is excellent for rubbing turned work of all kinds.

One of the real problems in rubbing is that of complete mechanical cleanliness. A bit of infinitesimal grit on the surface of a rubbing pad may so score or scratch the varnish that another coat is the only possible answer. To avoid this, see that all pads are scrubbed clean with a brush and gasoline first and then lay them down only on an absolutely clean surface.

Again, see that the pans are freshly cleaned and the oil strained through a piece of cloth as it is poured into the pan. Rubbing felts may be purchased as English (cheap grade), London (good grade), or Spanish (extra quality) in ¼ by 3 by 5 in., ½ by 3 by 5 in., 1 by 3 by 5 in., or any size desired. In the end it pays to buy Spanish white felt; such pads, if properly cared for, kept clean, and stored in a flat and clean can, will last a lifetime.

Keep pads for water rubbing and oil rubbing entirely separate. Never attempt to make one serve two purposes, for to do so will produce a glaze on the pad that will be almost impossible to remove, and will cut and scratch a varnish surface.

THE next problem concerns itself with the pumice stone, a ground-up form of volcanic rock. Each grinding of the dry rock is floated over tanks of water, allowing the finest to float on to the second tank, where partial settling occurs to produce FF or twice floated; and the finest ground material is carried along on the surface to the third tank where it finally settles to produce FFF. Previous to use, this pumice stone should be inclosed loosely in a double thickness of cheesecloth, sifted on to a clean paper, and put into a sugar sifter such as can be purchased in a ten-cent store. This provides a quick but clean method of distributing the pumice over the work previous to rubbing.

For turned work, a rubbing brush is dipped into the oil, then touched against a paper that has been dusted freely with pumice. Hold the brush by the far end to prevent spattering while the work progresses. Rub around the sharply turned parts and lengthwise along the plain, unbroken portions. Use a piece of thin hat felt dipped in oil and pumice to complete the rubbing. Thumb off frequently the long way of the work to check the quality of the rubbing, which should be carried only far enough to produce a clean, level surface free of nibs, scratches, or brush marks. Then dip a handful of clean white cotton waste or rags in water, squeeze fairly dry, and without adding any fresh pumice pick up the oil rubbing sludge left from the pads. Working as nearly in one direction as the character of the work permits, rub the surface to produce the satin finish so much desired.

In rubbing a flat piece such as a table top, a somewhat different procedure is in order. Wet the top with oil, sprinkle evenly with pumice stone, and cross rub the ends to cut level. Next rub from end to center, reversing the top from time to time. This will remove any traces of end cross rubbing and the double rubbing in the center is much desired. Thumb off frequently *with a lengthwise stroke only* and check against the light to see that all nibs are cut level. Use the rubbing brush to rub beaded or molded edges, then rub with the cotton waste dipped in water. Last of all, use a clean pad of waste wet with water to rub the face of the top with a stroke of even pressure. Wipe clean in the lengthwise direction only with a damp cloth and polish with a dry cloth. Inspect against the light, spot rub with the pad where necessary, dipping the pad in the *oil only* and without adding any pumice stone. Rub out once more with the wet waste as left from the first rubbing and reclean when through.

ASSEMBLE the table frame and top, if that is what the job happens to be. Then wipe and clean up with an oil polish. This may be prepared in a quart jar as follows: 3 parts crude oil, 2 parts paraffin oil, 1 part turpentine, 2 parts denatured alcohol, 3 parts water, and 1 part butter of antimony. Add in the order given and slowly beat in the alcohol, water, and butter of antimony with an egg beater. While using, shake well from time to time.

Apply the polish freely to a soft piece of old cotton flannel wrung out of water, and use evenly and quickly on the entire piece. Then clean up with a dry cotton flannel. These cloths should be washed with soap and water after use and put away to dry because they greatly improve with use and washing.

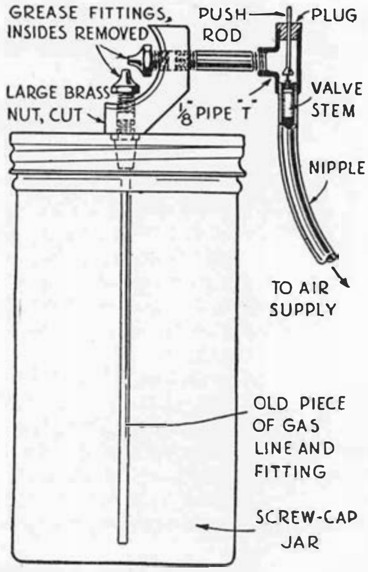
In many cases water rubbing is preferred to oil methods because it is faster, produces a harder, brighter surface, and is cleaner. It requires more skill on account of its cutting speed and should be undertaken cautiously at first. A set of *separate* rubbing equipment is required. The only departure, however, from the standard oil-rubbing practice is the fact that the water-wet cotton waste is dipped into crude oil to rub out the water pumice left on the work as the final rub out.

In rubbing work in general, dissemble wherever possible, then reassemble for the final clean-up and inspection. In the case of the sideboard illustrated, the door panels were rubbed first; then the top and bottom rails; then the lock and hinge stiles respectively, the strokes being cut sharply across at the joint lines to clear out cross rubbing marks. Next the main body of the sideboard was rubbed out; the drawers taken out and rubbed; the top edge of the drawer front shellacked to prevent sticking; and the runners rubbed with a paraffin block and replaced. Then the top was rubbed. Last of all, the headboard was rubbed and replaced, and the entire case spot rubbed and polished as shown. When one considers that this piece appeared to have been dropped off a truck at high speed when brought in, it will be understood how a careful finishing job will restore furniture to its original color, lovely graining, and beautiful appearance.

It must be borne in mind that there are no short cuts in hand finishing high-grade work. Eternal inspection, vigilance in the manipulation of tools and materials, complete understanding of the processes involved, as well as a sense of good housekeeping—these are the price demanded to produce work in which the finisher can take justifiable pride.

WHEN using chalk for layout work, try mixing it with alcohol instead of water. It dries more rapidly. For coating finished surfaces preparatory to scribing layout lines, mimeograph ink may be used instead of copper sulphate solution, the fumes of which are likely to rust your tools.

SMALL PAINT GUN MADE FROM ODDS AND ENDS



HERE is a suggestion for making a small utility paint-spraying gun from junk. A large brass nut was cut so that there would be two sides at right angles. Two pressure grease fittings with the insides removed then were tapped in at right angles. The ⅛-in. pipe thread on them also allows for minor adjustment. The top fitting was tapped from outside for a ⅛-in. piece of pipe, which carries a pipe T on the outer end. The pipe T was plugged at one end, and a push rod inserted to operate the valve. An old tire valve was cut off and soldered inside the nipple leading to the gun.

The fitting in the jar depends on the size of the old piece of gas line tubing used.

The advantage of this gun is that it will operate on 75 or 80 lb. pressure very well, whereas a regular gun must have the pressure regulated. A regular air compressor, of the type used for pumping tires, will operate this spray gun perfectly. If this is not available, use the home-made compressor described elsewhere in this book.

Enameling *the Modern Way*

New Materials and Methods Enable You to Rival the Flawless Work of a Professional Brush Hand

ENAMELED woodwork or interior trim was considered a beautiful but expensive luxury only a few years ago. The enamel then in use was the so-called "oil type," expensive and slow in drying. It could be applied only by the most expert of brush hands because of the great difficulty in preventing sags or drips. Today our modern four-hour or quick-drying enamels, whether in flat, egg-shell, or gloss forms, can be applied successfully by anyone who will take the time to study the accompanying photographs and follow the suggestions I am going to give.

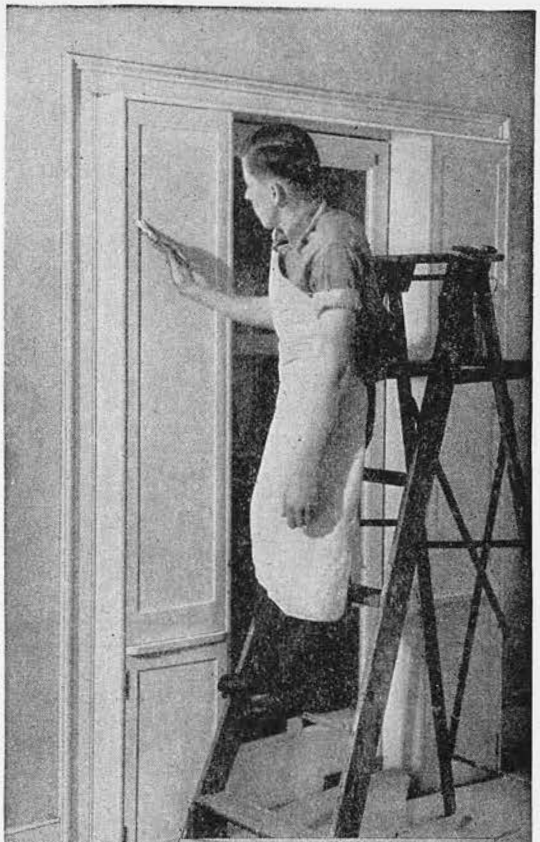
These new materials have made their appeal not only to men who take pride in keeping their homes shipshape, but also to women, who find in them the answer to their never-ceasing demand for an easy brushing, nonsagging, quick-drying, cover-in-one-coat type of enamel for use in touching up furniture.

For the majority of enamel work, two types of brushes are desirable. Furniture, with its narrow and often turned surfaces, requires a semisoft brush of the 1½ to 2-in. fitch, bear, or oxhair types. The latter is perhaps the best for the home worker who has learned to buy a few first-quality brushes and take proper care of them. For larger and broader surfaces such as interior trim and doors, the standard form of black China bristle known as the XXX (triple-X) varnish flowing type will do a fine piece of work. Brushes 1, 2, and 3 in. wide are suitable for this.

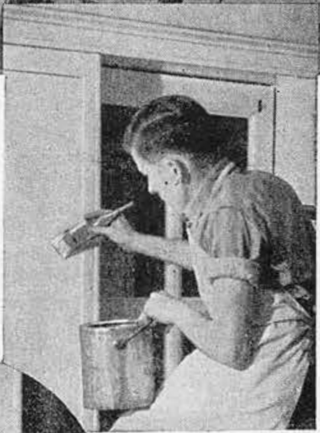
Before the brushes can be used in enamel, they should be carefully dry-cleaned by flicking the bristles across the fingers, then washed in turpentine, and last worked in varnish to fill the bristles at least a day or two before use, if possible. Before dipping them in the enamel, use an ordinary table knife to scrape the varnish from the brush without getting the bristles out of shape. Do not wash the brush in turpentine, or the traces remaining in the heel of the brush will cause the enamel to bubble or even foam while being applied.

Be sure to prepare the surfaces by washing with a trisodium-phosphate cleanser, starting from the bottom of a panel, rather than the top. Rough surfaces are smoothed with wet-or-dry sandpaper, used wet. To keep the surface clean just ahead of the brush is one of the really vital problems of good enamel work. One of the most practical means is to use a so-called "tack rag." An old handkerchief is good because of its hemmed edges. Dip the cloth in water, wring quite dry, and then sprinkle lightly with varnish. Refold and rewring so that the traces of varnish permeate the cloth. Keep it rolled up in a piece of oilcloth or waxed paper when not in actual use to prevent drying out. Should this occur, sprinkle with water and wring out again.

First, carefully dust off the work with a regular dusting brush; then wipe off with the tack rag to pick up any traces of lint

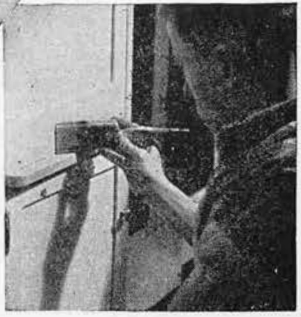


1 To commence an enameling job such as this, run the panel line with a narrow brush. Do not cover the rails (cross members), stiles (uprights), or the panels themselves



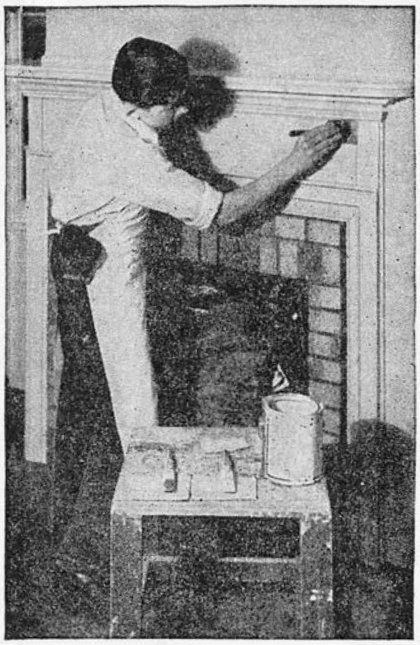
2 A wider brush is next used on the panel. Apply the enamel with overlapping strokes laid on in an X-fashion

3 The panel is finally tipped off with only the bristles of the brush. Avoid any pressure and work halfway up and halfway down to center of panel



4 The cross members of the panel, door, or other work are next brushed from the ends toward the center of each one

5 Finally the stiles are cut in so the brush strokes cross the brush lines left when the rails were coated in the previous operation. Avoid any retouching once the enamel has begun to set



Starting to cut in a molded panel on a fireplace. Incidentally, the bricks were cleaned with a trisodium-phosphate washing powder

and dust. Pay particular attention to the lower corners of panels.

Now let us study the series of photos so that operations may proceed in their natural sequence. Whether the work involves the trim on a French door and bookcase ensemble, a fireplace panel with mantelpiece, or the wider and more involved handling of large panels, the procedure remains practically the same.

IN the first operation on panel work (Fig. 1), a narrow brush is used to run the panel line itself so that the small square or molded edge is freely covered with enamel, working *from each corner toward the center* of each side and end, when the brush is lifted off and redipped in enamel. When dipping the brush, immerse the bristles not more than an inch and "spat" the brush against the inside face of the half-full container to distribute the enamel evenly through the bristles and to remove any excess. Do not work directly from a full new can and do not wipe or drag the bristles over the edges of the can. This removes too much material from the brush and causes dripping on the outside of the can.

Now change to a 2- or even a 3-in. brush, dip it in the enamel, "spat" it against the container, and then apply *quickly* with X-brush strokes, as in Fig. 2, repeating until the entire panel is covered.

With a single drawing stroke from ferrule to bristle tip, wipe the brush almost dry on each side over the edge of the can and then use the *tips* of the bristles only to quickly "tip off" the entire panel (Fig. 3), working from the top halfway down and from the bottom halfway up, when the brush is lifted off.

Now coat in the bottom cross rail and then the top, working from left and right to the center in each case. Notice throughout that all brushings must be done *from* all corners and not toward them, or the enamel will be dragged out of the brush and start a bad sag or drip down from the corners.

Finally, change to a narrow brush and cut in the stiles of the panel in such a manner that the brush quickly but lightly crosses the ends of the top and bottom rails, thereby giving a clean-cut effect where the joint between rails and stile would naturally occur.

Avoid back tracking or touching up. Rather wait until the new surface has properly hardened, then sand, dust, and tack off, and in the case of a panel, coat in entirely. Never try to patch a panel.

AT no time must there be any amount of heavy and vigorous brushwork such as is required in outside painting. Rather the light, quick, and easy freedom typical of good varnish work is what is necessary. The beginner will do well to start in the least noticeable section of the room. In this manner he can learn how the material works, how much it can be brushed, how little is needed to get easy coverage, and most important of all, how quickly it sets.

For successful work a temperature of 70-75 deg. F. is about right, while the wet bulb should be around 10 deg. less for ideal conditions. As a matter of practice, these conditions are not as easily controlled in the home as might be desired, but the heat can be and should be kept as indicated whenever possible. Ventilation should be arranged so that a free flow of clean air is available constantly. For this reason enamel work should really be done whenever possible during the summer months. In the winter months, keep the room closed and quite warm until the enamel has "set"—about an hour—then open the windows top and bottom about an inch so that free circulation may be had, but without drafts, which might cause the enamel to chill and subsequently wrinkle.

Avoid any inside paintwork, including varnishing and enameling, during the extremely hot, humid weeks of midsummer, or the materials may remain sticky and collect dust for a considerable period.

BRUSHES which have been used in enamel should be thoroughly rinsed in turpentine. Work the bristles carefully to remove all enamel from the heel of the brush. They should then be rinsed again in clean turpentine and suspended in a varnish brush keeper reserved for enamel brushes alone. Keeping the brushes immersed in varnish in this way maintains the elasticity of the bristles and insures their being ready at all times to do a fine, clean piece of finishing. Without this care brushes inevitably get "seedy" in the heel and as a result spread tiny lumps or specks of material in the new enamel film.

Considerable experience has proved that a roll of red, rosin-sized building paper may be used to advantage for cutting strips to cover the floor, rather than cloth. This paper is heavy enough to withstand stepladders and sawhorses. It keeps spots from going through and staining the floor, and best of all does not contribute lint to float around the room and settle on the fresh enamel or paint.

A SUGGESTION as to the type of enamel best suited to your needs: If the woodwork is newly erected and freshly sanded, it should be primed with a coat of half floor varnish and half turpentine. Under no circumstances use shellac, which, while fast drying, is too brittle and affords too little adhesion to both the wood and enamel to be durable after the first year. The varnish primer is tough and long-lived. For the second coat, use equal parts of enamel and undercoater, followed by two coats of finish enamel as furnished in the can. The last coat can be rubbed dull with FFF pumice stone and water, wiped clean, and oil polished with old cloths.

For used woodwork or where rubbing is too laborious or expensive, use an egg-shell enamel final coat. Because of its lack of excessive gloss it does not show up dents and other minor imperfections.

• • •

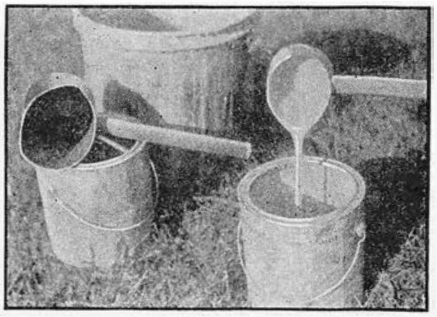
Heavy brown paper glued around the edges of a stack of boards will hold them together while being cut on the scroll saw or band saw. If the outside parts are to be used, they can be separated easily by using a razor blade.

LACQUER BRUSHES KEPT CLEAN WITH ACETONE

A cleaner for lacquer brushes that may be used in an emergency as a satisfactory and inexpensive substitute for the regulation lacquer thinner is acetone, a colorless liquid that can be obtained at drug stores. On relatively unimportant work it can also be used as a thinner for cellulose lacquers provided one part of amyl acetate is added to every five parts of acetone. Brush marks on lacquered work can be removed by spraying with acetone. You will also find that acetone makes an excellent quick-drying thinner for ordinary shellac.

TIN-CAN DIPPERS AID IN PAINTING

For handling gummy or sticky liquids such as paints and oils, a serviceable dipper can be made from a No. 2 or 2½ tin can in a moment's time with a pair of tin snips. Such a dipper is more convenient to use than an empty can just as it comes from the kitchen, and it saves soiling the fingers and avoids wasting material. Besides, it can be thrown away after use, since it is easier to make a new dipper than clean an old one. Cut the top of the can off at an angle and fasten it with two nails to a broomstick handle about 12 in. long as shown in the accompanying photograph.



This type of dipper is so easily made that it is thrown away after use to save cleaning

METHODS OF Coloring Ship Models

THE correct coloring of ship models is of vital importance. Notes on the color of the various parts are sometimes given with the description of the vessel. If not, one must apply the usual coloring for the period and nationality.

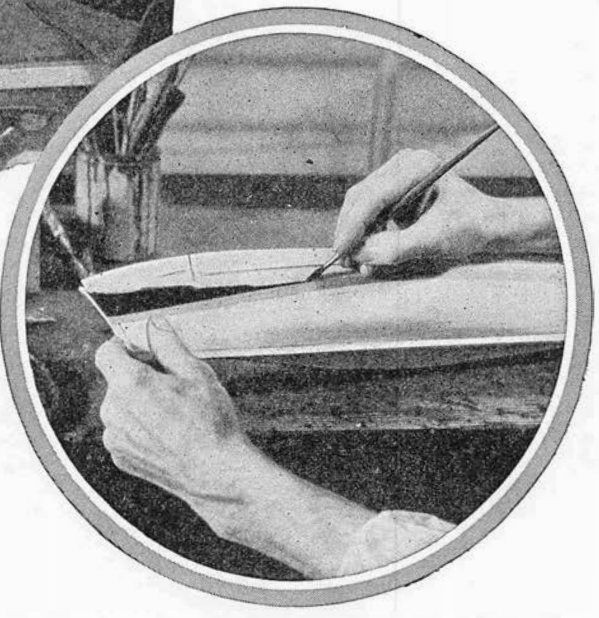
Ships up to the sixteenth century seem to have been largely of unpainted wood. Presumably they have unpainted, oiled upperworks and were tarred or oiled outside, with occasional touches of bright color, such as red wales, blue bulwarks, or painted shields hung along the pavisades. When religion was predominant, sacred devices were often painted on the sails.

Oak was, at that time, the favorite wood for shipbuilding, but oak is unnecessarily hard for model work and its grain is out of scale. A softer wood stained a not too dark oak color will represent it. Where a Stockholm tarred effect is wanted, diluted Brunswick black will give it exactly, or a mixture of mahogany and walnut stains can be used.

For painted surfaces of this period it is wise to keep to the earth colors, such as yellow ocher, light red, and cobalt.

The underwater body was usually tallowed, and tallow is white. Blank white paint, however, would not look right, so rub in some blue and green with your thumb at the bends, along the keel, and in similar places, and then wipe on some raw sienna.

Whether or not to antique ships of these and later periods is entirely a matter of preference. The ships were certainly not antique when they were sailing. Their paint was bright and their sails white. Nevertheless, many think that models of medieval vessels look more natural when judiciously antiqued.



Painting along the water line. A strip of decorator's masking tape or gummed paper is used to insure a perfectly true division

A little unevenness in the staining, with perhaps some darker brown rubbed in corners and on the undersides, will be sufficient. Raw sienna and Vandyke brown or burnt umber are the most useful antiquing colors.

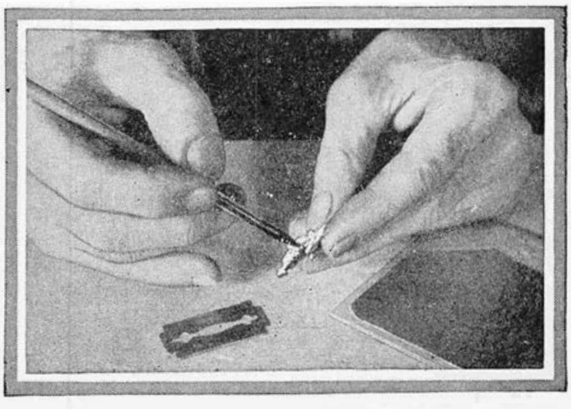
The sails can be dipped in tea or coffee, but you can get a better effect by painting them with very thin stain, perhaps adding a touch of color at the clews.

The masts of any period can be assumed to be one of the pitch pines (much like Oregon pine), which is of a burnt sienna color. Paint the spar with a thin coat of this transparent color, with just a touch of Vandyke. If it is large enough, "comb" it down with a ragged brush to get the long grain effect, and then apply a coat of varnish.

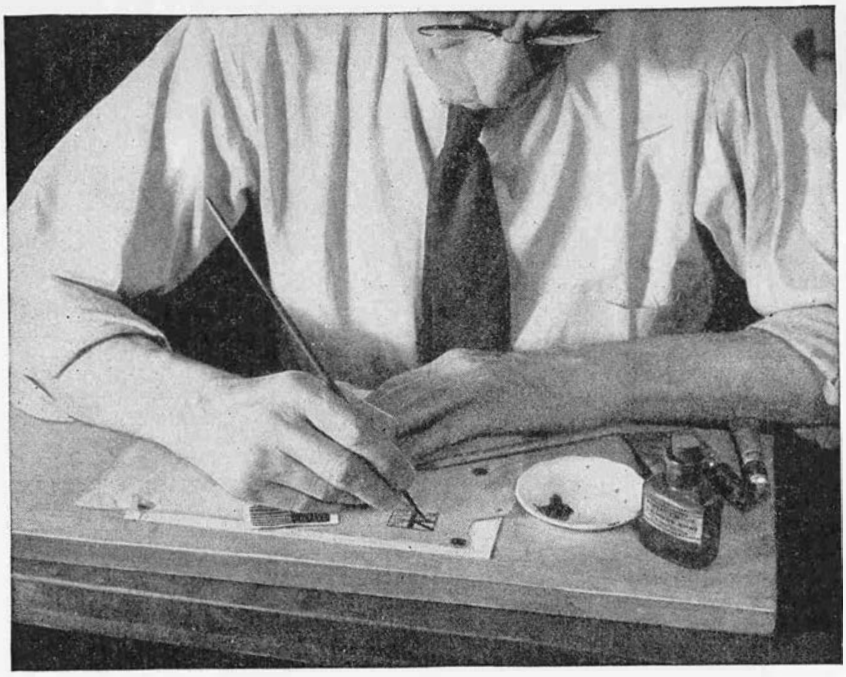
Ships of the late sixteenth, seventeenth, and eighteenth centuries were much the same but with a good deal more paintwork than their predecessors. The Elizabethan ships were especially gay, their fancy patterns giving way in time to red, black, yellow, and white stripes, with much light blue on Catholic ships. For these effects, instead of painting one coat directly on the raw wood, several ground coats should first be given.

Ships of the late eighteenth and nineteenth century period, including clipper ships, were painted all over, except for hardwood and rails, carved work, and the like. Even the masts (except between the doublings) were painted white, black, or some color. The underwater portion was by this time, however, covered with copper sheathing. Such ships should not be antiqued at all. They must have a neat, sleek, but not yacht-like appearance.

As all the other modern sailing vessels will be more or less modifications of the clipper ship, let us take up the painting of one. The painting of the hull should be completed before any rigging is set up. If the hull is to have real copper sheathing, this should be put on first; if not, then the whole, after careful sandpapering, should have a thin coat of shellac, followed, if it is a large model, by a thin coat of paste wood filler, carefully wiped off. Next a coat of flat white



Applying genuine gold leaf to the figurehead for a model of the galleon *Revenge*. The effect is better than gilt paint



is applied. This will show up any inequalities or scratches, which should be entirely eliminated at this point to save future trouble. Thick paste wood filler makes the best putty for small work.

Two or three coats of flat white should then be applied. Allow each to dry thoroughly and rub it down with No. 00 sandpaper between coats. Mark in the water line; and along it, above, lay a strip of decorator's masking tape, or gummed paper with a perfectly smooth edge. See that it adheres closely all along. Paint up to this to imitate copper color, with burnt sienna and Indian red. Work some emerald green in the bends and here and there where the verdigris would cling. Artist's oil color is preferred for this blending work. One coat should be sufficient. Metallic paint can be used, but with it you will not be able to get an effect that is really satisfactory.

WHEN this is thoroughly dry, remove the tape, wipe off any stickiness, and place another strip of tape on the bottom paint to meet its edge exactly. Coach paints ground in japan are the most satisfactory for the upper part of the hull. Dilute the color quite thin with turpentine and brush on one coat after another until you have a body of color built up; then very carefully sandpaper and rub down with powdered pumice stone. Next apply more coats, using less turpentine but adding varnish in increasing proportions until the final coat is an enamel. The gloss of this will probably be too high, so rub it down with pumice stone; or what is easier and rather better looking, is to sandpaper it lightly and apply a thin coat of dull-drying or "rub-effect" varnish. This can be used on the lower part of the hull also. As an alternative, this type of varnish can be used to mix with the paint.

This will give an even, all-over coat, but a more artistic effect is obtained on a black hull by painting the last coat with a stiff brush and working in a little blue and red direct from the palette without mixing them. The colors should not be obvious, but they will give the black some life.

A white or colored stripe, if on a molding, can be first painted its color and then omitted when painting the body color. Either a molding or a flat stripe, however, may be more easily painted after the body color is dry by using two stripes of masking tape. If unable to manage this neatly, where there is no molding, glue on a strip of thin paper and paint that. For white lettering on black, leave a patch of white and then outline the letters with a pen in India ink; this, when varnished, looks just about the same as white paint on black.

FOR inside the bulwarks and for deck houses and the like, use white (or colored, if called for) coach paint, giving them two or three thin turpentine coats and one with dull drying varnish. These parts and the masts and yards should be painted as one progresses, preferably before being fastened on the model.

Colored lacquers have been used on small models with success, but oil paints are preferable. There are, however, some occasions on which to use lacquer. Glue will not adhere firmly to oil paint, but the cellulose household cements will stick to lacquer because they soften it and reach the wood beneath. It is therefore more convenient to lacquer any part to which other parts will have to be cemented. At an early stage of the model, to keep the decks clean, give them a coat of clear lacquer, used for this reason. Do not apply lacquer over paint.

IN making a good model, many little brass parts are required. These look neat if polished and lacquered, but that is rarely correct. One hears of a sailing ship arriving with her brasswork gleaming, but the extent of this would be the rim of the wheel, binnacle top, gratings on the skylights, a few poop belaying pins and deadlight rims, if any. It would not include jackstays, yard trusses, capstans and the like, which were iron.

The deck ironwork was usually black, but sometimes green with red pump wheels. The ironwork aloft was usually the same color as the masts or yards, but was sometimes black on white wood. Mast bands were frequently painted in this way. Iron on natural color spars might be black or white.

Blocks in early ships appear usually to have been left unpainted, but in later vessels they were painted to harmonize with the spars.

Deadeyes got a liberal dose of tar along with the lanyards, so should be black. Anchors and old-time guns were always black.

Chain should always be black, never gold or silver. The best way to blacken copper is to dip or paint it with a solution of liver of sulphur. To oxidize brass, make a solution of hyposulphite of soda, 1 oz.; lead acetate, ½ oz.; and water, 1 pt., at 180 deg. F. If paint is preferred, there is a mat lacquer used for painting the metal work on cameras that is excellent. Use this also for touching up the rigging where necessary. It and other lacquer colors can be thinned with a special thinner or acetone.

With regard to gilded parts, a book of real gold leaf does not cost much and lasts a model maker a lifetime. On small surfaces it is easy to apply and will look permanently like gold. Japan gold size is used to make it adhere; but for all one needs in this work, some thin shellac, varnish, or even glue will do. Leave the adhesive until it gives just a suspicion of tackiness to the back of the finger. Cut small pieces of the leaf with a razor blade and apply them with a dry camel's-hair brush which has been drawn a few times over the coat sleeve or hair.

The best flags are painted on thin silk. This can be done by drawing the pattern on paper and pinning the silk over it so that the lines will show through. Artist's water colors can be used by mixing gum or fish glue with the water to prevent them from running. Oil colors, however, are preferable because the colors are stronger. They can be used by extracting most of the oil on blotting paper and then mixing them with any of the liquids sold for painting fabrics. Another way to prevent the color from running is to rub into the silk a pounce such as is used on tracing cloth by draftsmen to prepare it for inking. The edges can be hemmed on large flags, or wiped with clear varnish to stop them from fraying.

Do not gum up your model with heavy paint and destroy the beauty of your neat workmanship, yet do not let it have a starved appearance. A little cleaning with a file in corners is sometimes helpful. Work for color harmonies, contrasts, and a vibrating, lifelike effect as if you were painting a picture, which, indeed you are.

These hints are not intended for finishing prototype or sailing yacht models, which require highly glossy surfaces.

SAILS FOR SHIP MODELS

MANY ship model builders have a hard time finding cloth that is sufficiently fine to use as sails on an accurately detailed model. Ordinary draftsman's tracing cloth, with the stiffening ingredient boiled out, is excellent. Being thin and closely woven, it looks like real sailcloth "scaled down." New tracing cloth can be used, but it will be found just as satisfactory to use old tracings, as the ink will wash away with the filler. It should be lightly starched and ironed before being cut to size.

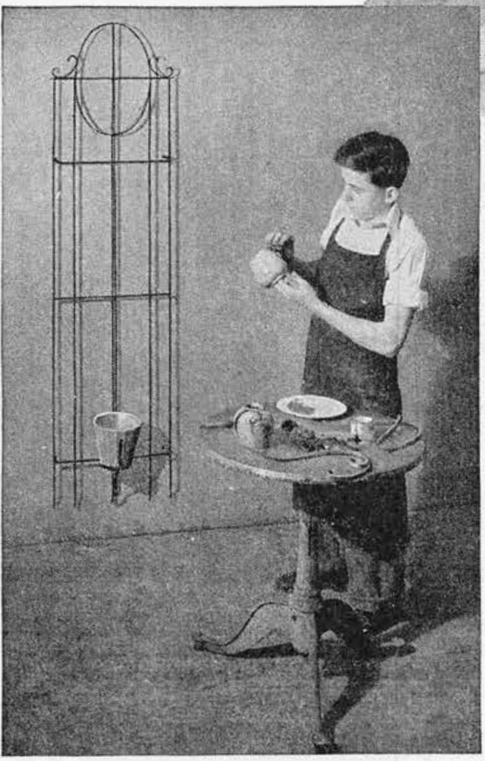
Step-by-step instructions for a variety of beautiful ways to finish

Wrought Iron *and* Ginger Jars

The metal is cleaned with emery paper and denatured alcohol; then lacquered and finished with enamel by means of a rag pounce

FROM the time of the crusades or even before, artisans have been able to develop finishes for iron and steel that have endured to this day, almost proof against rusting and decay. Among these finishes was the color now known as "forge black." The metal is first well cleaned by sanding with No. 00 emery cloth or steel wool, then washed with denatured alcohol (shellac grade) to remove handling grease, and dried. To prevent finger spotting the cleaned metal, it is advisable to use clean cotton gloves, which should be washed as often as they become soiled.

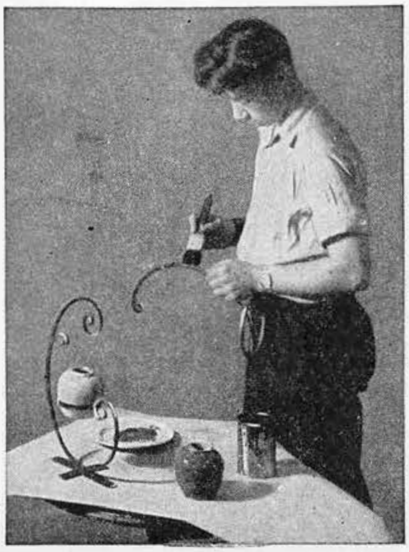
As soon as possible after drying, the metal is coated with linseed oil by brushing, dipping, or spraying, and then heated over the forge with the air blast on, so that free carbon is added to the burning oil, which gradually assumes an enamel-like form. When the oil stops smoking, but without warming the iron above a black heat, the process is complete, except for wiping with a cloth to remove free soot after the metal has cooled. This method leaves a warm, dull black finish.



Applying a sponge glaze previous to blending out with a brush. Note how the fingers are held inside of the bowl to avoid spotting the finish. The decorator below at the right is working on a colonial panel frame

Since all the designs illustrated were done in cold metal with no forging, other methods of finishes are equally applicable. The materials required are dull black brushing lacquer and dull black fast-drying enamel; five other fast-drying enamels in ¼-pt. cans—jade green, coffee brown, Delft blue, white, and Chinese red; ½-pt. clear brushing lacquer and some lacquer thinner; denatured alcohol; turpentine; a little No. 2 steel wool; a pound each of FFF pumice stone and rottenstone; and several sheets of No. 4/0, 2/0, and 1/2 emery cloth. Several small soft-bristle rubber-set brushes of widths from ¼ to ¾ in. and a 1-in. curved handle rubbing brush complete the list.

For fireplace equipment a so-called "armor bright" finish is appropriate for the handles of the fire shovel, tongs, and log fork, with black on the shovel, tips, prongs, and fire screen. Armor bright, like forge black, is a very old metal finish and a replica of the color given armor metal by rubbing with fine abrasives.



Eggshell black enamel makes an effective finish for the ivy ring stand. In the front center foreground is a jar with a jade green glaze, although any color could be used

The handles of the fireplace tools are first cleaned with the steel wool, and then with pumice stone and water applied with the 1-in. rubbing brush, which is worked around the knobs and turned portions. Those workers whose equipment includes a motor-driven steel scratch-brush buffer can obtain excellent effects by using it; and a felt wheel and pumice may be substituted later for a different type of polish if the scratch-brush effect seems too coarse. Next the handles are washed in hot water containing some washing soda or one of the trisodium phosphate cleaning powders. Follow with a clean, hot-water rinse and dry in the air.

After the metal is cold and dry once more, apply a coat of clear brushing lacquer, holding the pieces by the lower portions below the polished area. Hang up with fine wires and let dry hard. With clear lacquer this will take about an hour, after which the bottom sections can be brushed clean; wiped with an alcohol-saturated rag; dried and then coated with dull black lacquer applied with another brush than the one used for the clear lacquer.

To touch up the fire screen, a dry, new floor scrubbing brush is first used, followed by a painter's duster. The widest brush at hand is then chosen to spread black brushing lacquer or enamel, not directly on the screen, but on a piece of tin or glass in order to remove the excess. The brush is next lightly and quickly cross brushed over the screen, first in one direction and then the other. For a fresh supply, the brush is simply rubbed on the tin or glass as required.

HAVING practiced on the fireplace tools, you will feel more confident of doing well with such pieces as the ginger jars and their wrought-iron frames and holders.

The metal is cleaned with No. 2/0 emery paper and denatured alcohol, as shown. Use a clean cloth saturated with fresh alcohol for the final wipe, and hold the work with a clean dry cloth to prevent finger spotting. In the case of the oval motif ivy stand, the finish decided upon was an antique or verd copper green. After the alcohol wipe, the frame is given a clear coat of brushing lacquer. As soon as it has dried, a small amount of copper brown enamel is spread on one side of an old china plate, and a bit of jade green is brushed out opposite. Next, two small scraps of cloth are rolled into separate bunches known as "pounces" in the paint shop, and held in shape with string or a small rubber band. A similar result can be obtained by clipping off small portions of sponge. In the case of the sponge, dip the pieces in water and squeeze out.

By using enamel over the clear lacquer, the effect can be increased, diminished, or otherwise modified as desired without "lifting" the lacquer from the metal, a procedure not possible where other types of enamels and varnishes are used in quick succession.

Hold the rag pounce or sponge between the thumb and first two fingers, being sure that the face of the rag is well wrinkled or folded unevenly. Apply lightly to the brown enamel, previously brushed out on the plate, so that the face of the pounce is covered evenly. Bearing in mind that this stand is to appear like green corroded copper, apply the brown coat in a light stippling motion from the base upwards and finishing with the top.

Next, take either a fresh pounce or a damp sponge and stipple on the green when and where you wish. The base should be a bit darker and browner. If the entire tone seems to be a bit new and bright, inclose some powdered rottenstone in a double thick cheesecloth bag and lightly dust the entire piece with the brownish gray powder. Do not handle further, but set aside to dry overnight.

THE next day, use a soft shoe brush or dry XXX varnish brush to dust off the excess rottenstone. The dusting is used to give the effect of time, handling, and indifferent cleaning, such as would be found on an old piece.

Much artistic work is possible by the simple methods just outlined, but in every case the craftworker is urged to strive for soft, subdued effects.

Because of the greenish glaze on the ginger jar, a dull black enamel was brushed on the ring stand. Where only gloss colors can be had in enamels, obtain a small can of eggshell or flat varnish made by the manufacturer of the enamels, and reduce small portions of enamel with an equal amount of flat varnish.

In the case of the colonial panel frame good taste suggested a simple eggshell black. The frame was first turned upside down for doing all horizontal cross members; then turned right side up so as to start work at the lower portion and complete the entire frame. The final touch-up was made by holding the side-wall brackets until the top oval had been coated.

Before attempting such work as glazing ginger jars in color, it is suggested that you go to your favorite store and in the glass and china department study the color effects and glazes.

Suppose you wish to obtain a rich Delft blue over the natural gray of the ginger jars, but with the gray tone showing through to soften and high-light the blue itself.

Note how the decorator in the center photograph on page 187 holds the jar, after its alcohol wipe, to prevent getting his fingers on the work in progress. In this instance he has a sponge pounce. By dipping the latter in water and squeezing it dry, the paint will not penetrate the sponge but will remain on the outer portion. The color usually should be applied somewhat heavier at the bottom of the jar; slightly less halfway up; considerably less on the shoulder where the high light or shine will occur naturally, and a bit heavier around the collar or rim.

FOR the jar shown, a bit of color from an artist's tube of blue was mixed with a trace of white enamel on a china plate until the desired shade was obtained. The pounce was applied to the color patch on the plate and then to the jar. A dry brush was used to blend the color more or less evenly by working in straight strokes from the *bottom* of the jar toward the shoulder, while the jar was held as indicated. Next the collar area was worked out and allowed to stand a minute or two for the enamel to "set." A clean, dry XXX brush was then touched with pure turpentine by allowing the tips only to meet a *film* of turpentine on a glass plate. By brushing lightly and evenly *from the shoulder down* towards the base of the jar, light streaks exactly like true glazes were secured.

It may be that your final effect is too bright or glossy, in which case it can be toned down by a coat of flat varnish. If no spray gun is at hand, it will be necessary to let the color work dry hard for a day or two, then use a 2½-in. soft, single thick varnish brush to apply a coat of dull varnish with quick *single* strokes, working from the bottom up and from the collar down to the roll of the jar. This must be fast, sure, and in single light brush-tip strokes or you will lift the color, and the job must then be repaired by touching up when the varnish is still wet.

PLYWOOD EDGES HIDDEN BY CELLULOSE RIBBON

WHEN plywood is used for making trays and similar articles, the edges can be neatly finished without additional trim by covering them with cellulose ribbon of the required width. Sand the edges smooth and square before gluing the ribbon in place, and hold it under pressure until dry. After one or more finishing coats of varnish or lacquer, the ribbon, if of the usual striped variety, will have the appearance of a band of colored inlay.

HOW TO GIVE TURNINGS A "FRENCH POLISH"

OLD as the so-called "French polishing" process is, many of those who have recently taken up wood turning have never learned this effective method of finishing woodwork.

The materials necessary are: orange shellac for dark woods, white shellac for light woods, denatured alcohol, an oil can containing ordinary light machine oil, a wad of cotton, and a piece of cloth free from lint.

After turning the work, sand it until perfectly smooth with a very fine grade of sandpaper. Care should be taken to avoid scratches. Remove the work from the lathe, wipe carefully to remove dust, and apply a thorough brush coat of shellac. Let it dry for a few minutes. This can be accelerated by placing the work back in the lathe and letting it turn for a minute or two.

As if by magic, a satinlike polish appears on the turned work

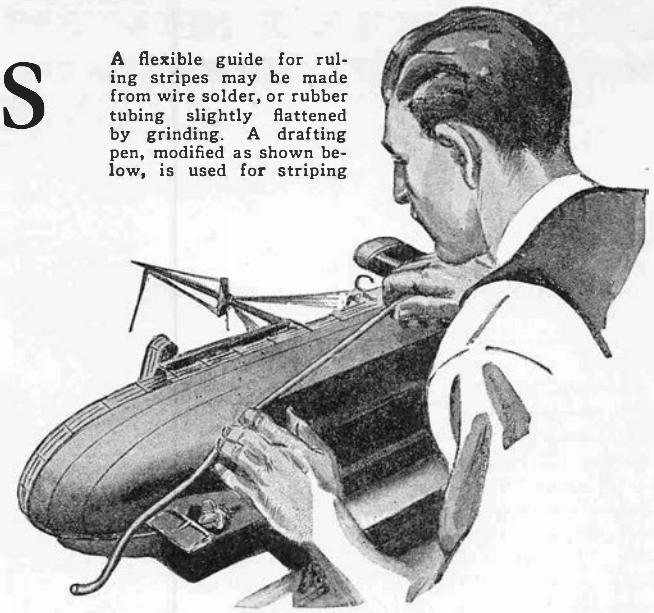
Next place a wad of cotton about the size of a door knob in the cloth, fold up the corners and edges, and tie with a piece of string. Dip this buffer into the alcohol, squeeze lightly, and shake once or twice to remove the surplus. With the brush, apply a little shellac on the working side of the buffer, and add a drop or two of machine oil.

START the work turning on the slow-speed pulley. Hold the buffer underneath the work and move it slowly from one end to the other, exerting a slight pressure with the hand. As the applying of this polish correctly requires considerable skill and experience, it is well to do a little practicing on unimportant work until the knack has been mastered.

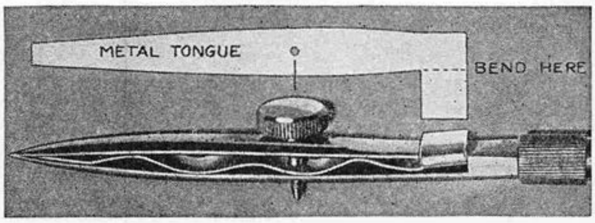
As the buffer dries out, resaturate it with more alcohol and add a few drops of shellac, but use the machine oil very sparingly. The more coats of shellac are applied with the buffer, the higher the polish. If the shellac gums up on the work, stop the lathe and smooth out the finish by using the buffer with a circular motion. Then proceed as before. Do not allow the work to rotate too fast. As if by magic, the surface will assume a satin-like appearance such as can hardly be duplicated by any other method of wood finishing. The surface becomes as hard as glass and resembles the finest of hand-rubbed piano finishes.

Pin Stripes

GIVE YOUR MODEL A MUSEUM FINISH



A flexible guide for ruling stripes may be made from wire solder, or rubber tubing slightly flattened by grinding. A drafting pen, modified as shown below, is used for striping



HAVE you ever critically examined the beautiful models in museums and at exhibitions? How the paint finish glistens, and how fine and delicate the pin stripes are! You naturally thought that painting those stripes must have been a tedious job, yet you can duplicate them very easily; and having once learned the tricks, you will find numerous opportunities to use the technique. For instance, you may want to pin stripe your car, or decorate some instrument you have made.

Then, too, you can use the same method when making fine dividing lines where the colors change at the water line on your boat models. Ordinarily this is done by pasting a paper mask on the hull, painting up to its edge, and removing the mask after the paint dries. That's where trouble sometimes develops; when the paper mask is removed, the dividing line becomes ragged. The method to be described will enable you to make those fine dividing lines almost razor edged. Furthermore, stripes or dividing lines may be run around all kinds of odd corners and over irregular surfaces with ease.

The actual striping is done with a drafting pen, which must be especially prepared for the work. It is necessary to provide more surface within the pen for the paint to cling to than when using the same pen with water-compounded inks. If this is not done, paint flows from the pen too freely. A simple little metal tongue will do the trick. Made of thin sheet metal as shown, it is inserted in the pen between the blades and is held in place by means of the regular adjustment screw. Notice that the tongue is wavy. This shape provides many small wedge-shaped crevices.

Now we come to the paint itself. Ordinary pigmented varnishes and enamels creep badly and will destroy the fineness of hair lines. It is much better to make your own paints, testing them each time before using them to make sure that they will not spread after being applied to a model. For this purpose a few tubes of ground-in-oil pigments of the desired colors should be purchased. The actual mixing is best done on a glass plate with a broad metal spatula. Squeeze out a small amount of the pigment onto the plate, add a few drops of clear varnish, and smear the mixture around with the flat of the spatula until it is well mixed. Scrape it into a heap and see if it is barely fluid enough to run from the spatula in an unbroken stream. When it does, add just enough pigment to stop the running.

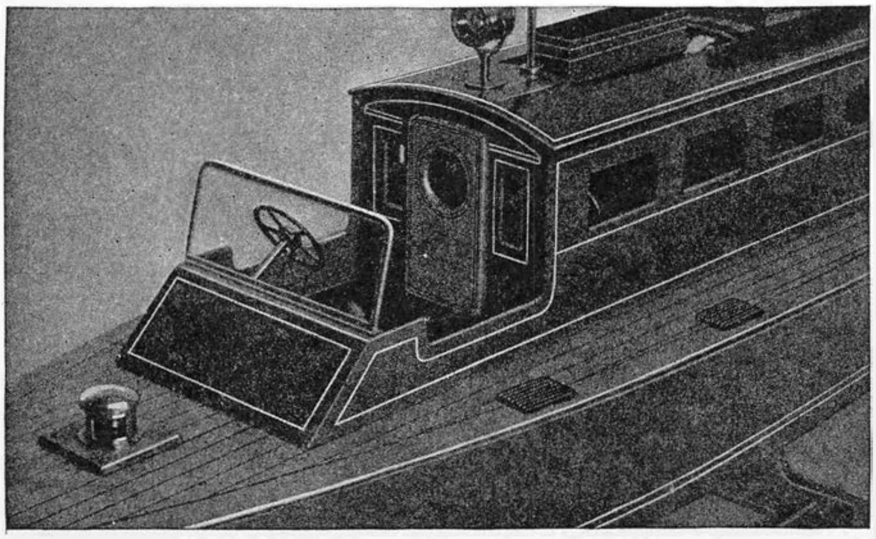
When loading the pen, be careful to see that the outsides of the blades are clean. Any paint here may lead the paint from inside the pen around the blades and onto the work. It is best to screw the blades together when loading the pen, and clean the outside with a small piece of linen before use.

The preparation of the surface is also important. Pumice and oil are used to rub down the surface where the pin stripes are to be made. Generally the final paint coat is rubbed down prior to finishing with varnish, and it is best to do the pin striping at this time so that the finishing varnish will protect them. If the stripes are to be put on over a high-gloss enamel, then a narrow strip where the stripes are to go should be dulled slightly with the pumice-in-oil mixture. A small piece of linen tied over a lead pencil eraser forms a handy rubbing pad. Just before striping operations begin, the surface should be rubbed with the palm of the hand to remove all dust particles.

The neatest stripes are always made continuously from beginning to end. On flat surfaces, templates of heavy cardboard or celluloid may be used, but where the surface is irregular or corners are to be turned, a special form of guide will be needed.

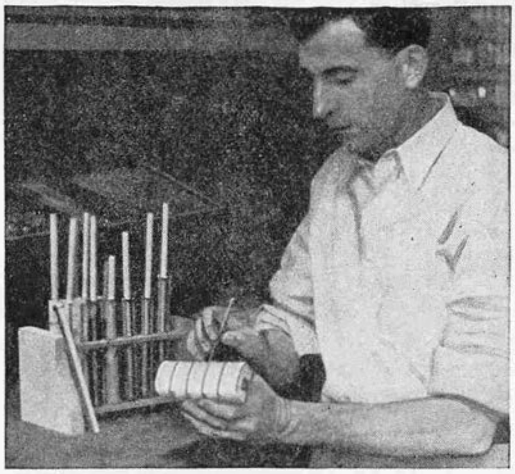
A ruler of extreme flexibility is easy to make from a piece of ⅛-in. rubber tubing. The tubing should be ground flat on one side along its entire length. This may be done by running it between a grinding wheel and the tool guide or rest, after properly adjusting the clearance between guide and wheel. Before the ruler is to be used, this flat surface is coated with rubber cement, which is allowed to dry. When dry, the cement will still be sufficiently tacky to enable the tubing to be attached to irregular surfaces simply by pressing it into place. It may be removed from the painted surface without the slightest injury to the paint.

Quite often ordinary wire solder may be used to form a ruler for the pen. The wire should be straightened perfectly before it is bent to the special shape required. This may be done by stretching it slightly with pliers and a vise. Then place it carefully on a flat board until needed.



The addition of neat pin striping always gives a model a more professional look. These stripes were applied with a draftsman's pen, which was guided by templates and rulers as described

MODEL MAKER'S PAINTS KEEP LIKE NEW IN TEST TUBES


Long-handled corks are fitted in the test tubes so they can be pushed down as the paint is used up

EVEN when they buy colors in small cans, model makers and other craftworkers find much paint is spoiled between jobs through thickening. You can avoid this trouble by providing test-tube containers in which the corks can be pushed down to the surface of the paint, thus eliminating any air space.

A convenient way to provide such equipment is to build up sets of eighteen test tubes each. The drawing details a rack for holding tubes ¾ in. in diameter and 6 in. deep. The upper shelf is bored with ⅞-in. holes, while the lower has corresponding depressions made with a countersink.

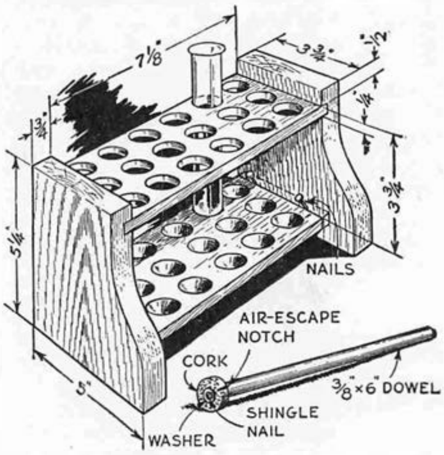
Fit the tubes with corks made by cutting ¼-in. lengths from ordinary bottle corks. Nail the corks to the ends of 6-in. pieces of ⅜-in. dowel sticks. Use metal or fiber washers under the heads of the nails. Sandpaper the edges of the corks so that, when lubricated with paint, they will slide inside the test tubes with sufficient binding to seal the sides. Make a very shallow groove to vent the air.

When putting the tubes into service, fill them about three-quarters full of paint from a freshly opened can, or from a used can after the paint has been stained through a clean, lintless cloth. Moisten the cork with the same paint and push it down to the surface of the liquid. The imprisoned air will work through the groove, and the drying paint will seal this slight opening.

Group the tubes according to color. If mixtures are made, save the residue. When several racks of tubes have been accumulated, assemble colors and their tints together, for convenience in locating them. After using the rack, store it on a closed shelf or in a deep drawer, away from dust.

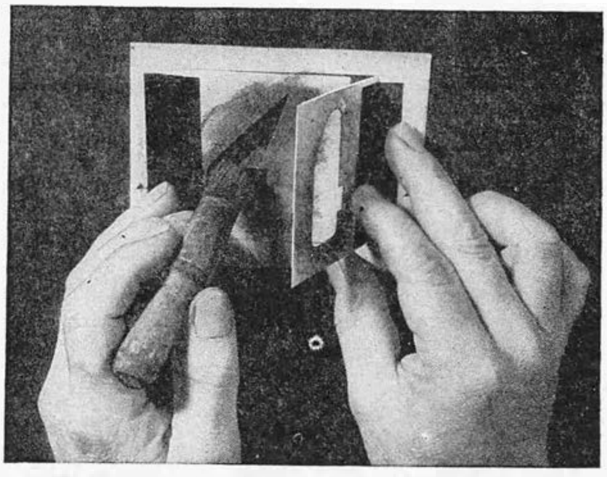
Buying small cans of paint is expensive. By the use of racks or tubes, either pint or quart size cans may be bought without fear of waste, and at a relatively great saving in cost. When a new can is opened, pour it into small bottles or 3-oz. mayonaise jars and seal them. Then use these smaller containers to replenish test tubes.

It will be found that the contents of a ¼-pt. can of paint can be kept in four or five of the tubes.



How the paint rack is made. Four or five test tubes hold the contents of a ¼-pt. can

HINGED STENCIL LEAVES NO GAPS


A hinged stencil for the figure four. First one part, then the other, is used, making a figure without unsightly "ties"

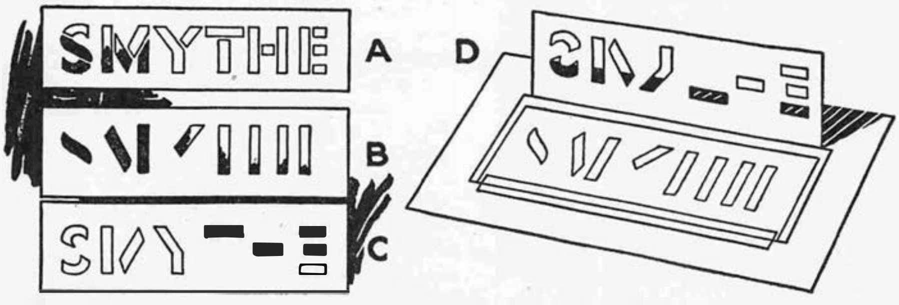
MOST craftsmen are familiar with the ordinary single stencil *(A)*, but few outside of professional ranks are acquainted with the double stencil *(B, C)*. The single stencil has "ties" or intervals between component parts of individual letters which produce a spotty appearance in the painted word or design.

The double stencil eliminates these unsightly gaps. It is made in two parts and applied in two operations. The parts are cut so that the holes forming the design overlap or supplement each other, thus eliminating the need of ties and strengthening the stencil. The double stencil's greatest drawback has been the difficulty in obtaining accurate registration of the two parts. This is usually achieved by placing the second stencil over the design painted by the first so that it appeared to be "right," or by cutting "key" slots in the second stencil to fit over designated parts of the first.

The hinged double stencil *(D)* avoids all the difficulties of obtaining accurate registration, but is practicable only with quick drying paints such as water colors, tempera, japan colors, printer's inks, and lacquers, or with more slowly drying colors when applied on highly absorbent surfaces.

The stencil frame is made either of the same material as the stencils or of a sturdier material of the same thickness. If the stencil components are of paper or fiber, the hinge may be of gummed paper or adhesive tape, which should be shellacked after application to repel moisture. If metal stencils are used, they may be fastened to a metal frame with small butt hinges soldered in place. After the first stencil section is hinged to one side of the frame, the other section is placed in register and hinged to the other side.

In operation, one section is painted in while the other remains folded back *(D)*; then fold back the section already painted and use the other section.



The ordinary type of single stencil with "ties" is shown at *A;* the two parts of a double stencil appear at *B* and *C;* and these are combined at *D* by hinging them to a suitable frame

HOW TO BAKE ON ENAMEL

ALTHOUGH baking enamels give a most durable finish to metal parts and are not so likely to become marred as are ordinary lacquers, they are seldom used in the workshop because of the absence of a baking oven. A substitute for an oven can be quickly made, however, and it will give satisfactory results for small jobs where quick production is not necessary. Only a wooden packing case of suitable size and an electric reflecting type heater (such as are frequently used in the bathroom) will be found necessary. The most satisfactory method is to cut a hole in one end of the case so that the heater can be placed against it and thus project the heat inside. The lid should fit tightly, but no additional insulation is necessary as wood is a fairly good heat insulator.

HOW TO CONSTRUCT AN

Outdoor Fireplace

FOR PICNICKING IN YOUR OWN GARDEN

YOU can often enjoy the pleasures of outdoor living no farther away from home than in your own garden. When there isn't time to take a long trip, when the roads are crowded and dusty, when duties prevent your going away, you can still have the fun of picnicking if there is an outdoor fireplace in your yard like any of those illustrated in this article.

An outdoor fireplace enables you to cook meals in real picnic fashion, and for some reason that always seems to make them taste twice as good as anything it is possible to prepare in the kitchen. You won't be alone in doing this, either, because the custom of lunching and dining outdoors is spreading rapidly.

In Southern California the outdoor fireplace has come to be an accessory that is second in importance only to the garage, especially in these localities where modern new homes are being built. The examples illustrated have therefore all been taken from that section of the country, where picnicking is a fine art.

The usual and most popular types of outdoor fireplaces are adapted to broiling or roasting meats and are familiarly known as barbecue ovens. Such fireplaces, of course, require a substantial foundation, especially in northern localities.

They are all comparatively easy to build. A pile of stone or old brick, a little cement and sand, and a piece or two of sheet iron are the essential materials. If these are on hand, the job is about as simple as building a house of blocks. The mortar commonly used consists of one part Portland cement and three parts sand. A little hydrated lime is often added to make the mortar easier to spread. About ten or fifteen percent as much lime as cement is the usual proportion.

In the drawings marked Fig. 1 is shown a design that can be built directly against a brick or stone wall, or isolated with a background of shrubbery. The amateur can construct it simply by following the courses or layers of bricks as shown in the drawings and in the photograph of the completed fireplace at the beginning of this article. It should be erected

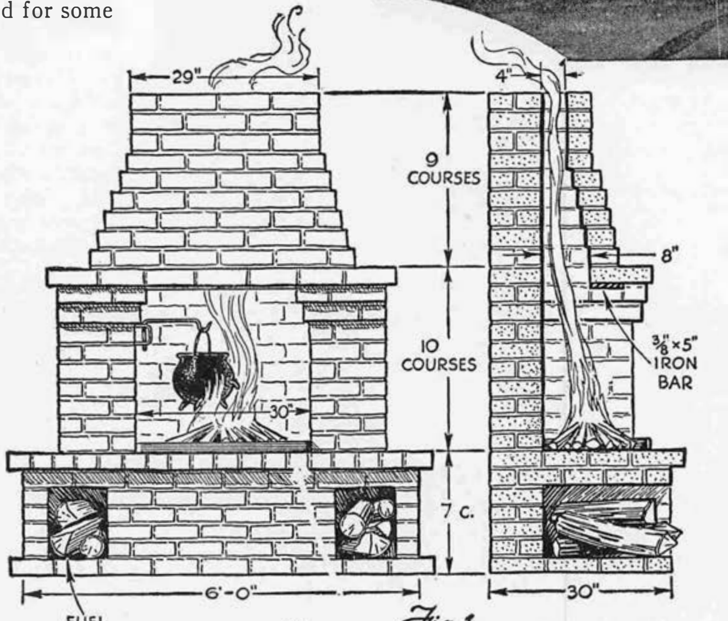
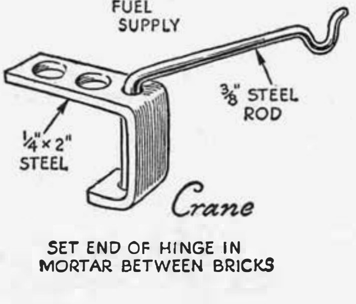
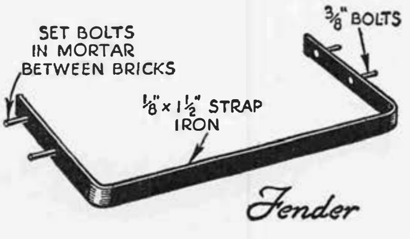


Fig. 1

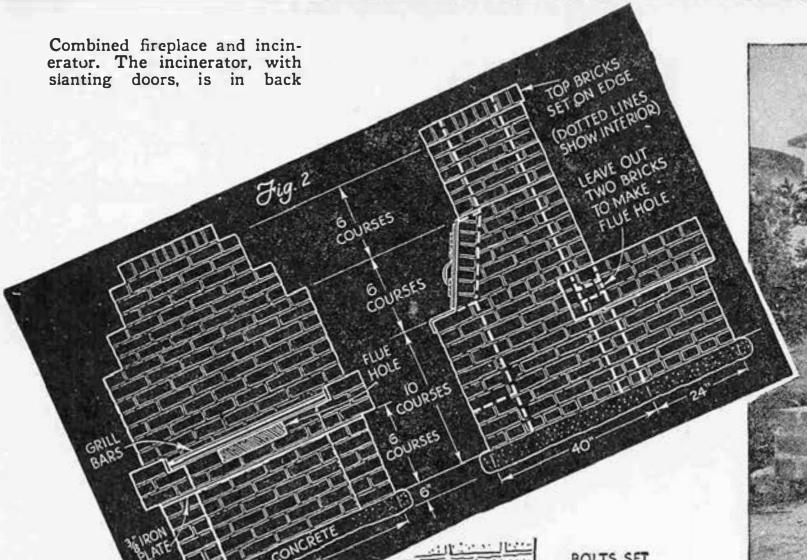


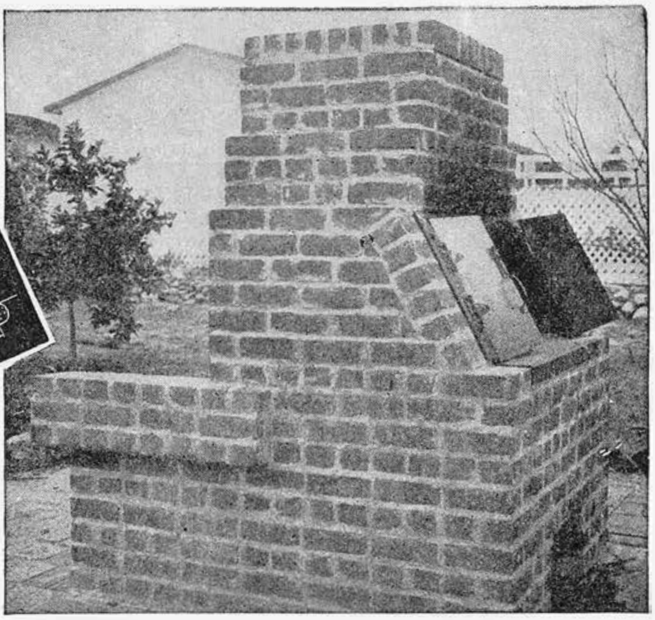
Crane



Fender

Combined fireplace and incinerator. The incinerator, with slanting doors, is in back

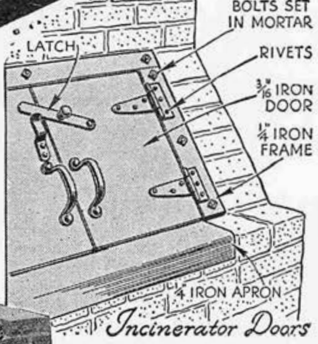




A side view taken slightly from the rear to show the opening into the incinerator section. Ashes are removed through a clean out at bottom

Wood is kept below the iron plate. The fire is built on the plate, and either a grill or a hot plate rests on a ledge two bricks up

upon a concrete or brick foundation. The crane support is embedded in the mortar or cement between two courses; and a flat iron bar is used to support the top of the fireplace opening. A rim or fender around the floor of the fireplace is made of iron.



The photo at right shows the fireplace marked Fig. 4 in the drawings below

A larger brick structure is illustrated in Fig. 2. It serves the double purpose of incinerator and broiler. The incinerator is in the back and out of view from the garden. A novel arrangement of the fire-box is used in this design; the charcoal is placed upon a broad, flat iron plate, with the grill or hot plate directly above it a distance of only 4 or 5 in. This design, which is somewhat modernistic, is built of common red brick. The opening below the iron plate in front is used for storing a supply of wood.

An exceptionally attractive fireplace is illustrated in Fig. 3. It is built of varicolored natural stones, arranged in an interesting pattern. An oil drum is used for the fire-box, after cutting away the ends and a section of the side. One pair of angle irons are riveted to the drum to support the grate bars, and another pair of them are installed above to support the hot plate or grill. The drum itself is set in concrete, and the stonework built around it. Flat stones form the tops of the seats.

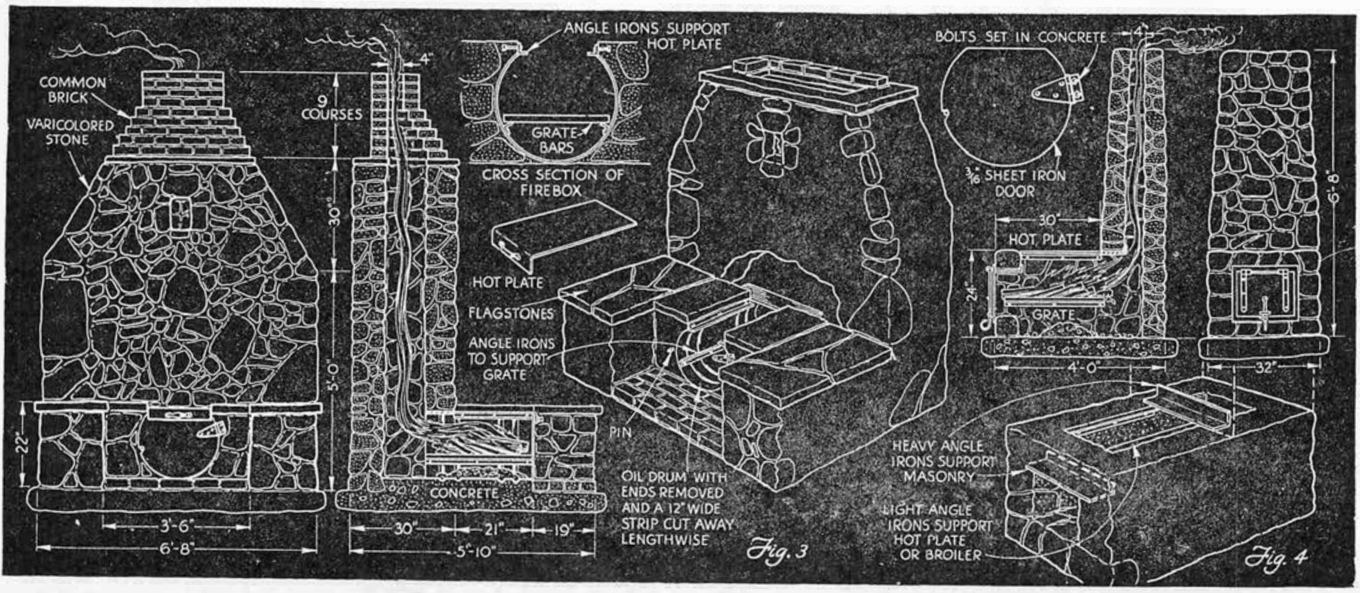
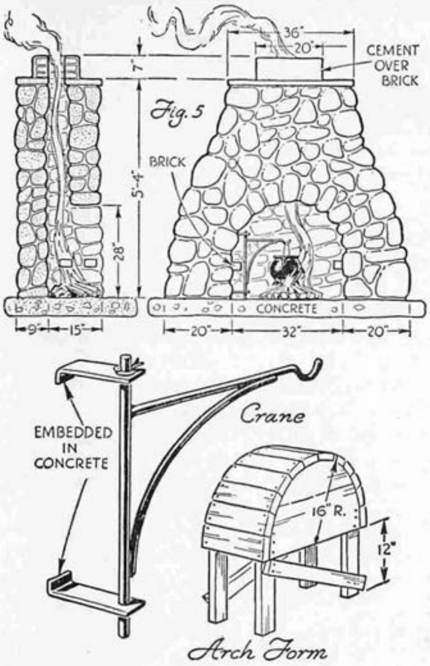


Figure 3 is a varicolored stone fireplace with an oil drum for the firebox; Fig. 4, one of field stone built with angle-iron reinforcements



Field-stone fireplace of picturesque design

Where field stones are plentiful, the plan shown in Fig. 4 is inexpensive. Grate bars, an ash-pit door, and a flat plate and broiler are required, together with a heavy flat bar to support the masonry of the chimney above the fire box.

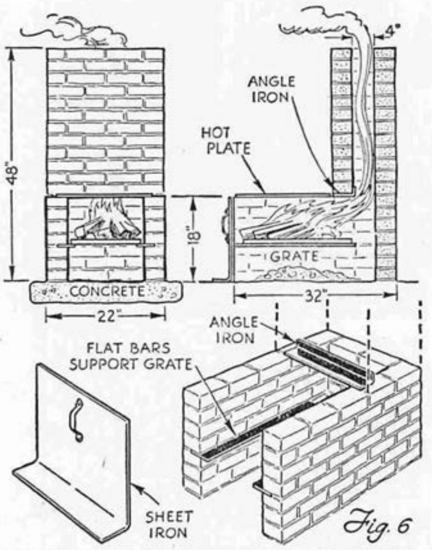
The fireplace of Fig. 5 provides for broiling, boiling, and toasting. The grill or broiler rests upon bricks jutting from the masonry, and the swinging crane supports a pot or kettle. Field stone is used in this particular fireplace, and with an arbor overhead providing shade, it makes a friendly corner of the garden on summer and fall evenings as well as at midday.

A still simpler fireplace of natural stone

About the simplest outdoor fireplace and barbecue it is possible to build is that shown in Fig. 6—merely walls of brick with two sheets of iron for the fire-box door and hot plate respectively. The grate bars rest upon two flat strips of iron laid between the bricks, as indicated. The dimensions can easily be altered to suit individual needs. The photograph immediately below Fig. 6 shows how the same idea may be elaborated to form a decorative outdoor barbecue oven under a veranda roof.

In the photograph at the bottom of the preceding column is illustrated still another simple type of outdoor stove.

Some of the ideas used in these fireplaces can easily be combined, if necessary, to make a design suitable for almost any type of garden or summer camp.



Outdoor barbecue oven under veranda roof

NAIL KEEPS BED SLAT FROM FALLING DOWN

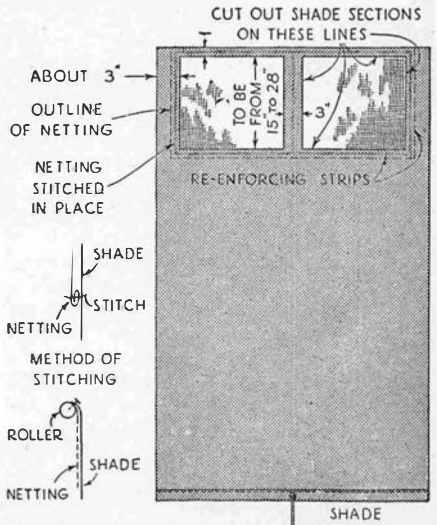
Wooden bed slats, which are often too short and as a result slide sideways and fall to the floor with a clatter, can be kept in place by driving a nail in one end of each slat and allowing it to protrude so that the slat will just drop into place. Even if the piece does shift somewhat, it still cannot turn at an angle sufficient to let it fall out.

VENTILATOR IN SHADE LETS WARM AIR OUT

Window shade with netting at top so that a better circulation of air may be maintained

A fully or even partly drawn window shade presents a barrier to the escape of hot, dry air from an overheated room. This difficulty can be overcome and one's privacy preserved by inserting a ventilator of mosquito netting, or similar mesh, in the upper part of the shade as illustrated. The netting can be obtained in various colors to match almost any shade. Stitch the netting on with re-enforcing strips, then lay a dry cloth over the ventilator and iron it flat and smooth. Retack the shade on the roller with the netting on the inside.

During the day, when the shade is not drawn lower than the middle of the window, the ventilator is invisible. At night the shade is drawn to within a few inches of the bottom of the window so that cool air can enter there and hot air can escape at the top through the partly open upper sash.



How shade is cut and netting stitched over openings

Testing and Adjusting Furnace Thermostats

THERMOSTATS for controlling house furnaces or boilers occasionally get out of adjustment with unpleasant results. It is really an easy matter, however, to check and adjust them.

First, examine the thermostat to see if it has a contact screw on each side, (Fig. 1), or if both screws are on the same side (Fig. 2).

If it is like Fig. 1, check as follows:

1. Swing the indicator to the left (lower temperature) to stop the burner (Fig. 1).
2. Note the temperature on the thermometer on the thermostat screen.
3. Move the indicator slowly up the scale until a point 1 deg. higher than the temperature shown on the thermometer. At this point the burner should start.
4. Move the indicator to the temperature shown on the thermometer, and the burner should stop. The starting and stopping of the burner is indicated by the sound of the motor in the basement or by noting a tiny spark at the contacts.

If the thermostat proves incorrect, adjust it by taking the following six steps:

1. Note the temperature on the thermometer, and remove the screen.
2. Move the indicator to the temperature noted.
3. Screw back the contacts (Fig. 1) so that they do not touch the contact blade.
4. Screw the right-hand contact screw *in* very slowly until it touches the blade (Fig. 3). The burner will operate at this point.
5. Move the indicator 1 deg. higher than the temperature noted.
6. Screw the left-hand contact screw *in* until the burner again operates. The adjustment will now be correct.

In case your thermostat has both contacts on the same side, check it as above, but move the indicator to a point 3 deg. instead of 1 deg. above the temperature noted on the thermometer.

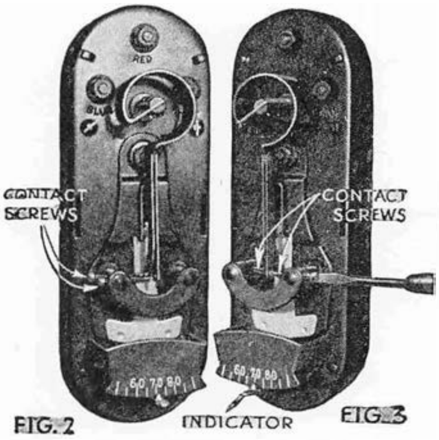


FIG. 2 FIG. 3

Left: One screw is turned in, the other out. *Right:* The screw is set to touch the blade

If this check reveals faulty adjustment, proceed as follows.

1. Swing the indicator to the left to stop the burner.
2. Note the temperature registered by the thermometer on the thermostat.
3. Remove the screen and hang it at the same level as the thermostat.

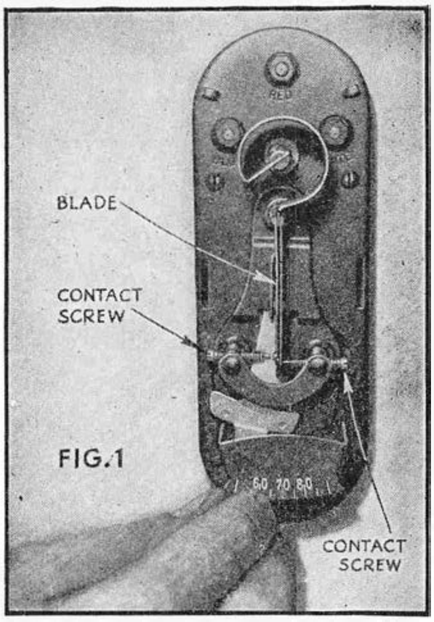


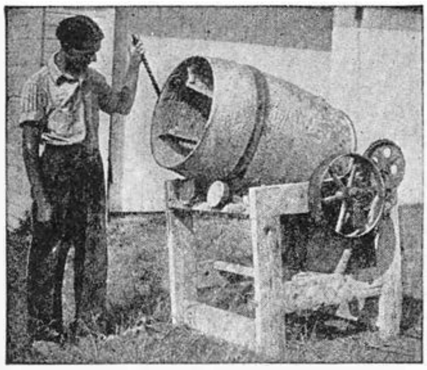
FIG. 1

Thermostat with contact screw on each side. The first step is to swing indicator to left

4. Screw *in* the outer contact screw one turn (Fig. 2).
5. Screw *out* the inner contact screw one turn.
6. Move the indicator to a point 3 deg. above the temperature noted on the thermometer, and while holding the indicator in place screw the *inner* contact screw *in* until the burner just starts.
7. Carefully move the indicator back to the temperature noted on the thermometer and screw the *outer* contact screw *out* until the burner just stops.

In each case, the instructions for checking should be followed after the adjustment is made.

Concrete Mixer Made from Steel Barrel and Junked Parts

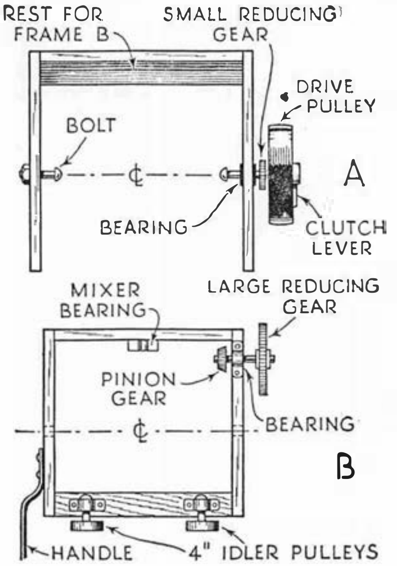


To empty the concrete, the barrel and the framework on which it rests are tilted forward

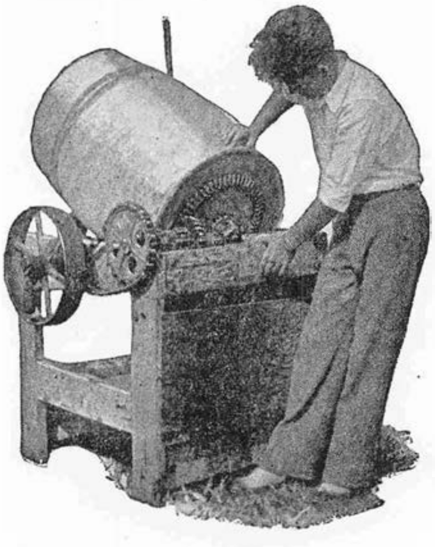
A SMALL but sturdy concrete mixer can be made very reasonably from parts obtained at a farm-machinery or auto junk yard. The required material is: a steel barrel; two idler pulleys 4 in. in diameter with ¾-in. face, and bearings for each; a drive pulley about 14 in. in diameter and clutch, which can be retrieved from farm-machinery junk; a chain reducing gear; a ring gear and pinion assembly; some 2 by 4 in. and 2 by 6 in. lumber, and assorted bolts and nuts.

The drive pulley is mounted on the side of a frame of 2 by 6's, open at the front as seen in one of the photographs and at *A* in the diagrams. The pinion and reducing gear are mounted on a frame of 2 by 4's, along with the bearings for the mixer barrel, as shown at *B*. This frame fits within the heavier outer framework.

The ring gear and a short axle are bolted to the bottom of the barrel. The axle must be centered properly to prevent wabbling. Pivot the frame *B* ahead of its center of gravity so it will rest on the stand until tilted.



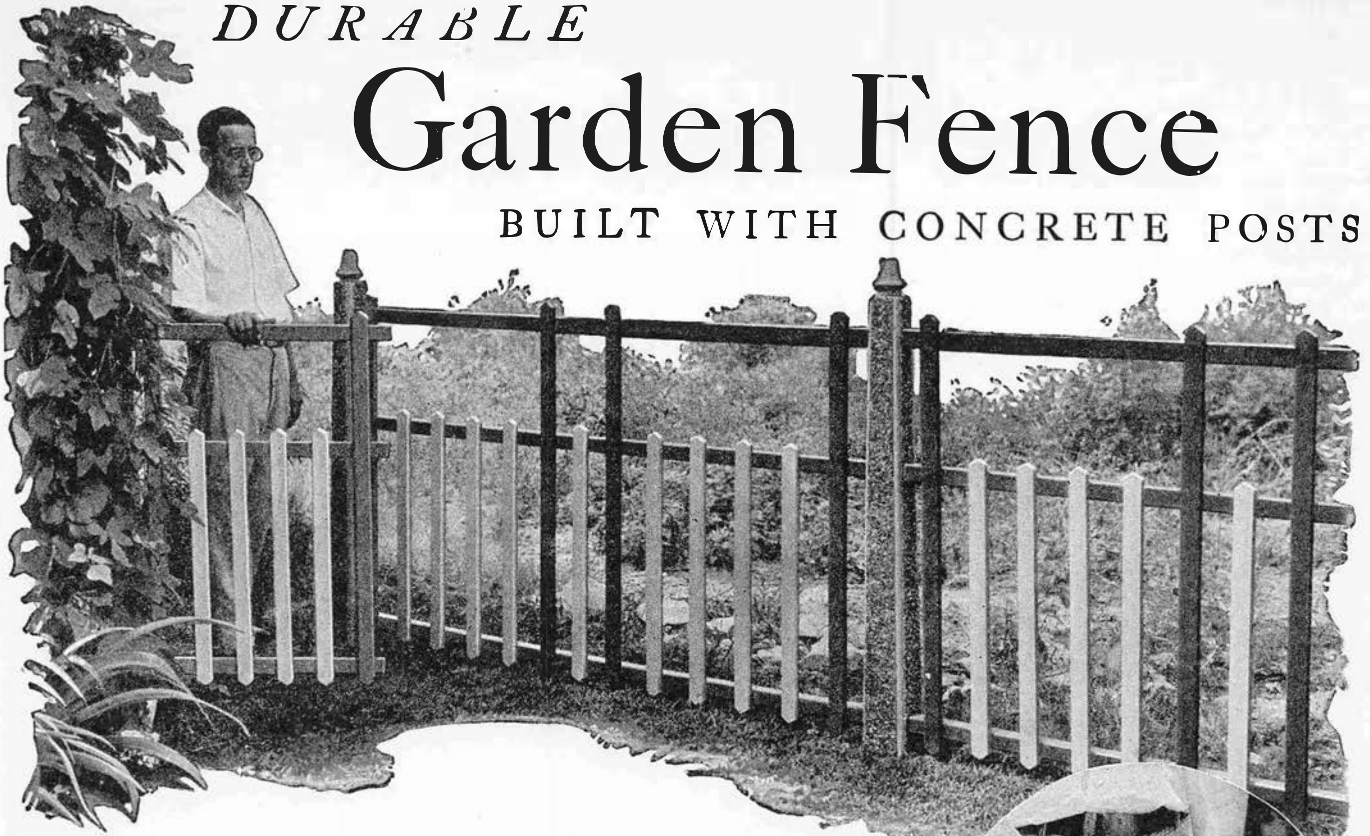
Top views of the main framework (*A*) and the auxiliary frame, (*B*) for supporting the barrel



A rear view of the mixer to show in detail the ring gear and method of driving the barrel

Four 3-in. baffles of heavy sheet steel are fastened with angle irons inside the barrel. If portability is of prime importance, a pair of old auto wheels and a trailer hitch can be added to the assembly.

DURABLE
Garden Fence
BUILT WITH CONCRETE POSTS



The materials for building this fence cost only about a third as much as plain wire fencing on cedar posts, yet it is more attractive and will last far longer

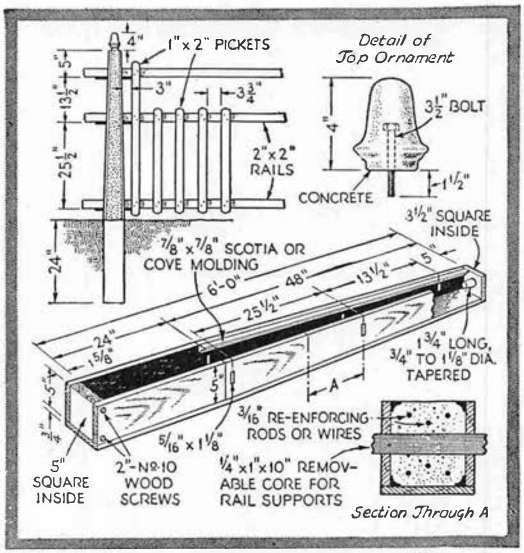
FROM the viewpoint of security and neatness, a good fence is a great aid to the back-yard gardener. Expense is the principal drawback. Even an ordinary fence of cedar posts and wire for a small lot is likely to cost $100 for materials, and it is not only unattractive, but it rarely lasts more than a few years. The trellis fence illustrated, which is much more durable, can be built for about a third as much.

The form for the concrete posts is made as shown in the drawing at the right. It is filled with a mixture of 1 part cement, 2 parts sand, and 3 or 4 parts torpedo gravel, sometimes called roofing gravel. For 30 posts, you will need 1 ton sand, 2 tons gravel, and 4 sacks of cement. Each post takes about 1 cu. ft. of the mixture. If a box 12 by 12 by 12 in. is used for a measure, very little concrete will be wasted.

Mix the materials very thoroughly while dry, then add water slowly until the mix will slide off a shovel easily. When poured into the form, it should be "quaky"—that is, it should shake a little like jelly. The form should be well oiled inside. Used crank-case oil will serve for this purpose.

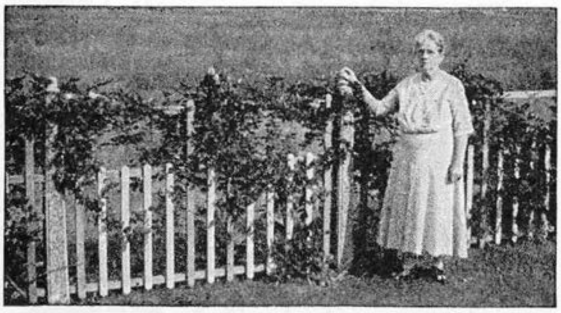
To strengthen each post, you can use about eight vertical strands of old woven wire fencing from the junk yard, but four 3/16-in. reenforcing rods would be even better. Shovel in about 1 in. of the mix, lay in several long strands of wire, put in the three cores to make the openings for the rail supports, fill in almost to the top of the form, place the other reënforcements, and complete the filling. Tap the outside of the form lightly with a hammer to jar the concrete, and scrape off any surplus from the top. The core pieces should be moved back and forth occasionally while the concrete is setting.

If a post is poured in the afternoon, it may be removed the following morning. Take out the cores first, remove the bottom block, stand the form on end, and slide it upwards. Hold a board along one surface to stiffen the still fragile post and lower it gently to a horizontal position, either on the ground or on two sawhorses



Method of constructing the form for casting the concrete posts, how the core pieces are inserted, the top ornament, and a drawing to show spacing of rails and pickets

Removing one of the top ornaments from the mold, which is nothing more than the upper part of a junked electric ceiling fixture



Since the fence is of trellis design, it is intended to be covered, in part or whole, with vines. This shows a section of fence after it had been erected for some time

Mixing the Aggregate
Removing Post from the Form

or boxes for convenience in the next operation.

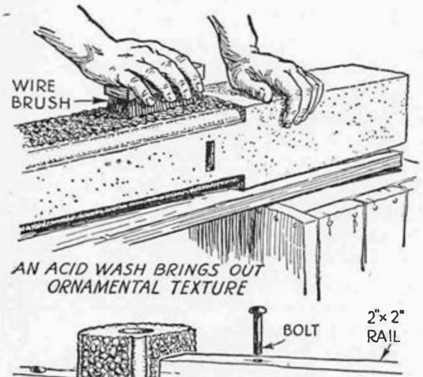
Apply 1 part muriatic acid and 1 part water to the flat surfaces with a stiff wire brush to remove the surface cement from the clean, sparkling surfaces of the gravel, but do not brush the round surfaces of the corners at all. After you have obtained the desired effect, which should be approximately that shown in the accompanying photographs, scrub the surfaces well with plenty of water and an ordinary scrubbing brush to stop the action of the acid. Patch any defects with thin cement.

Leave the post on the board until the next day, meanwhile casting another in the form. The finished post may then be set in the ground or put aside until wanted. If the weather is hot and the posts are stored in the sun, it is well to cover them with old sacks, which should be wetted thoroughly at intervals for a few days. Several forms can be made, if desired, to speed up the work.

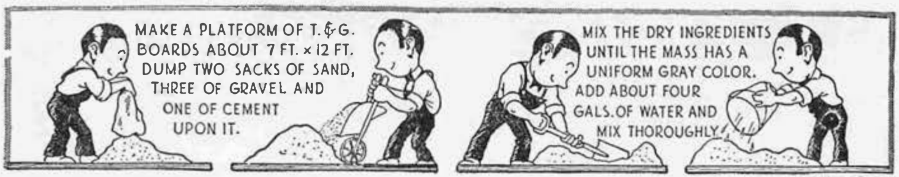
For rail supports, use 8 by 7/8 by 3/16-in. strap iron with 5/16-in. holes drilled about 1/2 in. from the ends. The rails are bolted to them with 2 1/2 by 5/16-in. carriage bolts. For corner posts or gateposts, special iron supports may be made by sawing the strap iron into two pieces and setting them into the open or top surface of the post while it is still wet.

The rails are 2 by 2-in. cypress. Fir or yellow pine 2 by 4's ripped down the center would be cheaper, but not so durable. The pickets are 1 by 2-in. cypress or ordinary furring strips. The spacing will be determined by the size of your yard. If you set the posts 6 ft. apart on centers, buy the rails in 12-ft. lengths. The rails and long pickets are painted apple green, the short pickets cream color. Give the pickets several coats of paint before nailing them with 8-penny common nails.

The top ornaments for the posts were cast in the canopy or upper part of a discarded electric center ceiling fixture. This was well oiled and filled with a mixture of equal parts fine sand and cement. A bolt about 3 1/2 in. long or an iron rod is set in the mix to project about 1 1/2 in. The finished ornaments are fastened to the posts by filling the hole left by the top core piece with very wet cement and pushing the projecting bolt or rod into it.

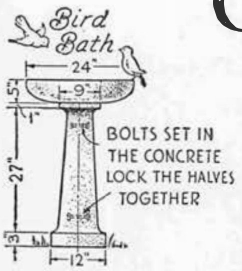


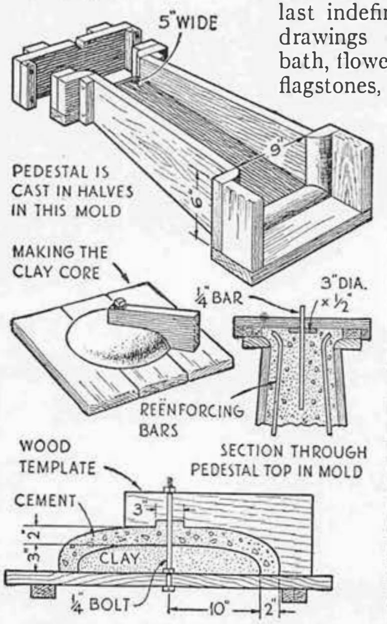
Sketches showing how posts are cleaned with muriatic acid and method of fastening rails

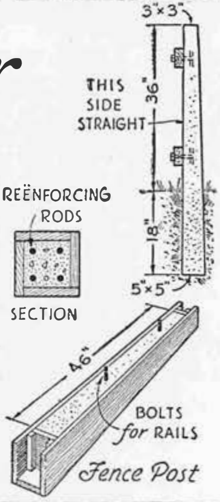

MAKE A PLATFORM OF T.&G. BOARDS ABOUT 7 FT. × 12 FT. DUMP TWO SACKS OF SAND, THREE OF GRAVEL AND ONE OF CEMENT UPON IT.
MIX THE DRY INGREDIENTS UNTIL THE MASS HAS A UNIFORM GRAY COLOR. ADD ABOUT FOUR GALS. OF WATER AND MIX THOROUGHLY.

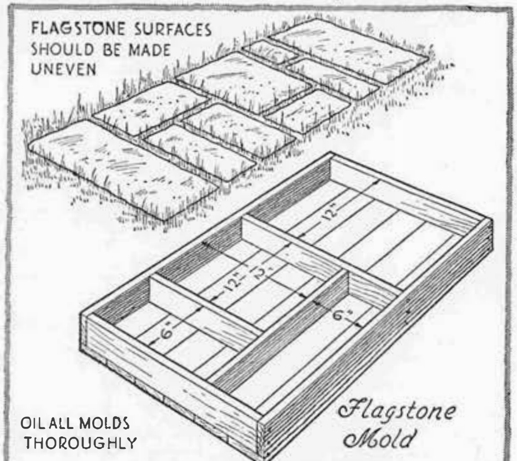
Concrete *for the* Garden

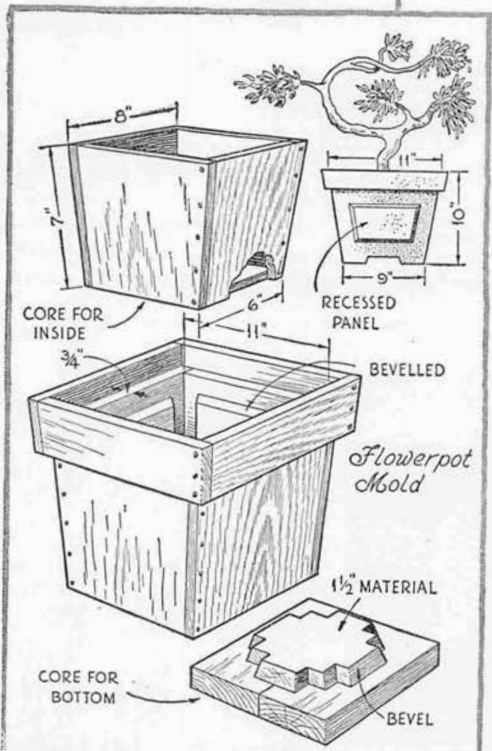
CONCRETE is so easy to cast in wooden forms that it is an excellent material from which to construct substantial pieces of garden furniture and flagstone walks. Properly mixed, it will last indefinitely. In the accompanying drawings are suggestions for a bird bath, flowerpot, Roman bench, lily pool, flagstones, and fence posts.

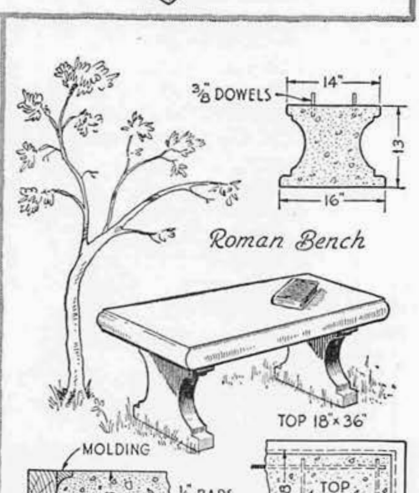








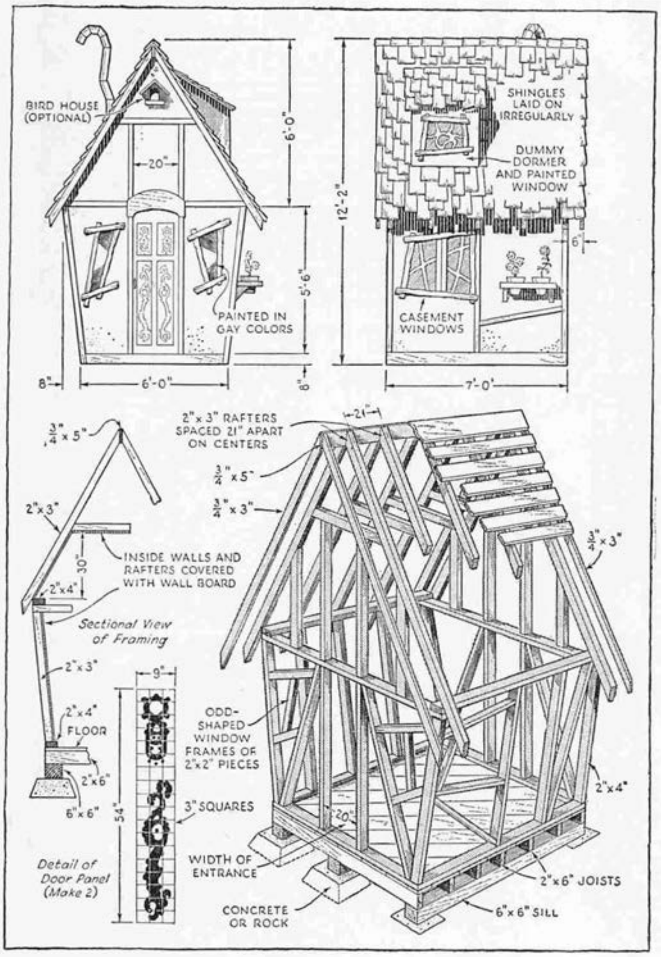


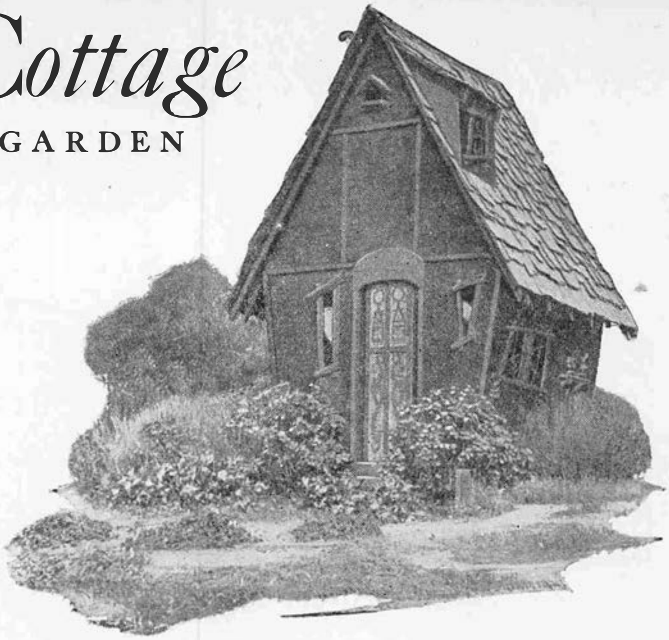


Sketches showing a variety of ways to make wooden forms and use concrete for garden accessories

A Fairy-Tale Cottage

TO ORNAMENT YOUR GARDEN





Used either as a child's playhouse or as a tool house, this building adds a quaint touch to any garden. The construction is shown at left

ORIGINALITY and imagination are embodied in this little fairy-tale cottage, which can be constructed in any garden at relatively small cost. Besides serving as an ornament, it may be put to practical use either as a playhouse for children or as a tool house.

The original building was erected in Laguna Beach, Calif., where it was found sufficient to cover the framework with wall board. The seams were concealed with battens and the whole protected against moisture with several coats of paint. Boards, wood siding, or shingles would, of course, be more substantial.

Wall board is fastened on the inside of the walls and over the rafters. There should be a vent in the ceiling and in one gable. The space under the peak of the roof may be used for a bird house, if desired, with an entrance in the front gable.

A bright color scheme such as red, black, and bronze, or light and dark green with orange trimmings is most effective. Plant shrubs of the more unusual varieties around the house and, if possible, lay a winding flagstone walk.

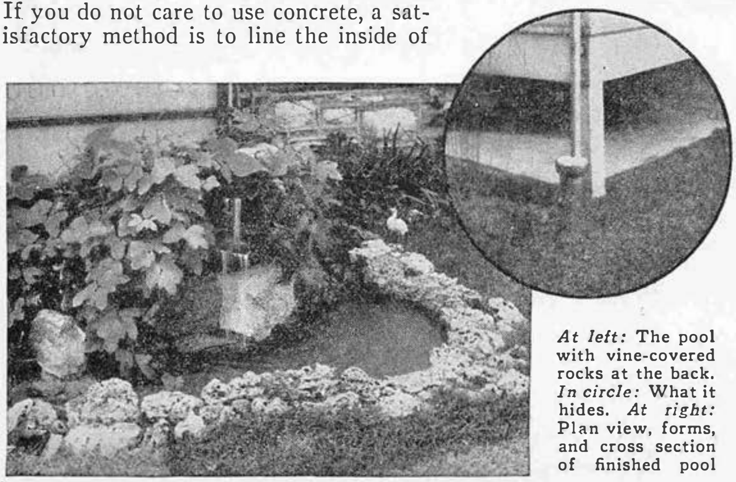
Small Rustic Pool Conceals Ugly Back-Porch Foundation

TO HIDE the unsightly back-porch foundation that is an eyesore in so many yards, a rustic pool and foundation can easily be constructed as illustrated below.

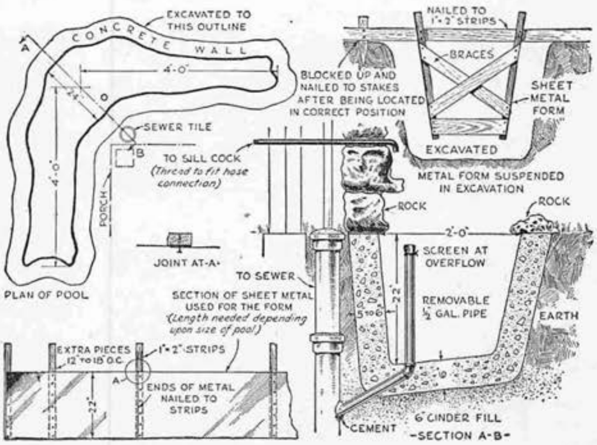
For the dimensions given, about 1 cu. yd. of a 1-2-4 mixture is required. This would be approximately 6 sacks of cement, ½ ton of sand, and 1½ tons of gravel. The form is made of sheet iron. If you do not care to use concrete, a satisfactory method is to line the inside of the excavation with stones from 4 to 6 in. in diameter, set in cement mortar and well pointed up.

An overflow pipe and drain may be installed as shown, or the water may be siphoned to the basement drain through a garden hose. The overflow can also be disposed of by excavating a hole about 2 by 2 by 2 ft. outside the pool wall and filling it with rock or gravel, then covering the surface with sod again except at the point where the water runs off from the pool. Water will gradually seep into the soil.

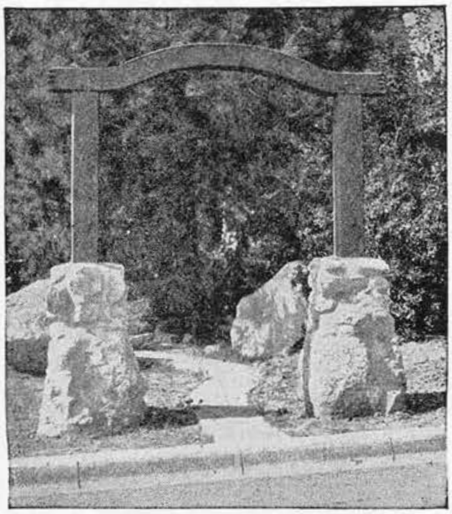
In building up the back wall, almost any variety of rocks may be used, but keep the appearance as natural as possible. A hose from a convenient sill cock or faucet will serve as a source of water supply unless a permanent piped connection is desired.



At left: The pool with vine-covered rocks at the back. *In circle:* What it hides. *At right:* Plan view, forms, and cross section of finished pool


EXCAVATED TO THIS OUTLINE
CONCRETE WALL
A
4'-0"
2'
O
SEWER TILE
B
4'-0"
PORCH
TO SILL COCK (Thread to fit hose connection)
JOINT AT -A-
PLAN OF POOL
NAILED TO 1" × 2" STRIPS
BRACES
BLOCKED UP AND NAILED TO STAKES AFTER BEING LOCATED IN CORRECT POSITION
SHEET METAL FORM
EXCAVATED
METAL FORM SUSPENDED IN EXCAVATION
ROCK
ROCK
2'-0"
SCREEN AT OVERFLOW
TO SEWER
SECTION OF SHEET METAL USED FOR THE FORM (Length needed depending upon size of pool)
22"
5 to 6"
REMOVABLE ½ GAL. PIPE
EARTH
EXTRA PIECES 12" TO 18" O.C.
1" × 2" STRIPS
A
22"
ENDS OF METAL NAILED TO STRIPS
CEMENT
6" CINDER FILL
-SECTION A-B-

Ornamental Arbors *and* Garden Gates



FROM these drawings you can choose the type of arbor or gate best suited to your own garden. Figure 1 and the photograph above show a gateway in Altadena, Calif. Figure 2 is a corner arbor with utility cabinets for books or craftwork supplies. Add doors to the cabinets if anything is to be left out in them. A good opportunity for lathe work and band-sawing is given by the gate in Fig. 3.

An arbor to be built over a garden walk is shown in Fig. 4; a shelter with shingle roof in Fig. 5; and a rustic arbor made from well-seasoned tree branches or sapling logs in Fig. 6. The bark may be left on the logs used for the latter if it is a variety that clings after becoming dry.

A decorative gate for a driveway is suggested in Fig. 7. Note how the heavy wrought-iron strap hinges also serve to reënforce the corners. The substantial gate in Fig. 8 is effective in an arched opening. It should preferably be built up of ¾-in. oak and allowed to weather naturally.

Figure 9 is a flower-basket seat of pine. The battens may be soaked overnight so they will bend more easily.

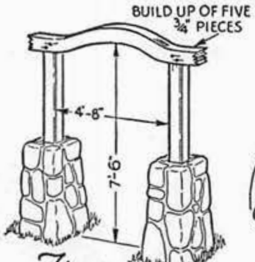


Fig. 1

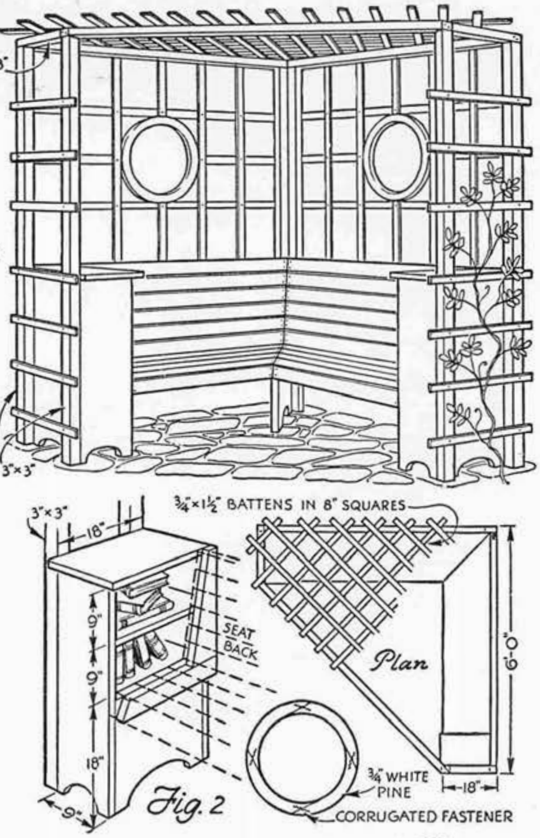


Fig. 2

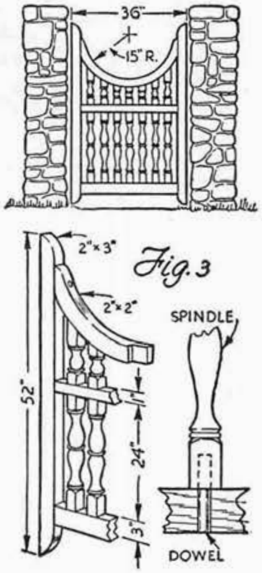


Fig. 3

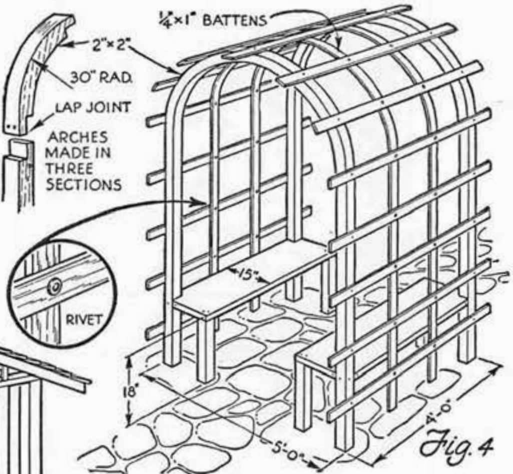


Fig. 4

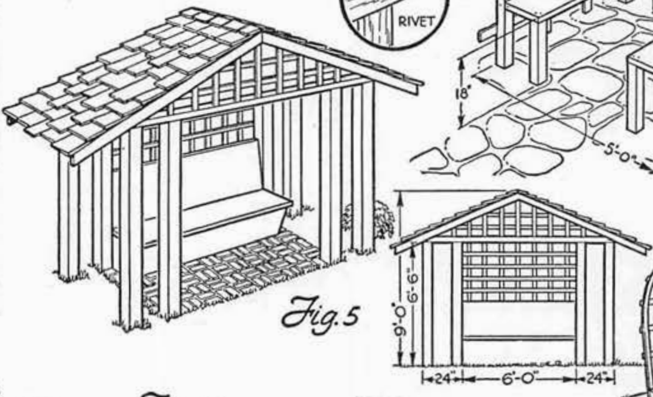


Fig. 5

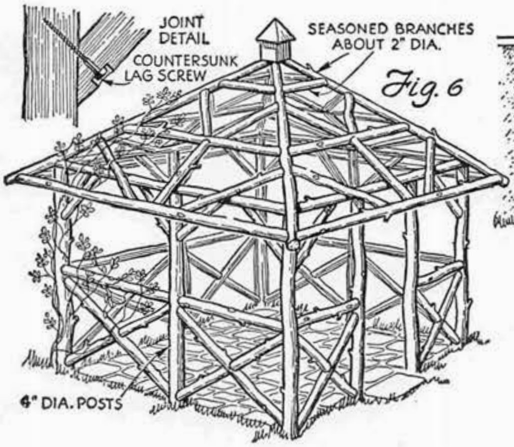


Fig. 6

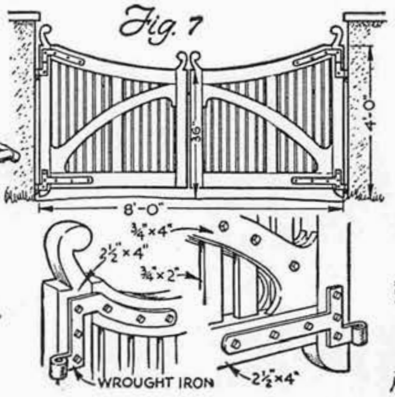


Fig. 7

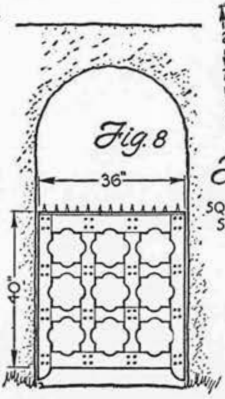


Fig. 8

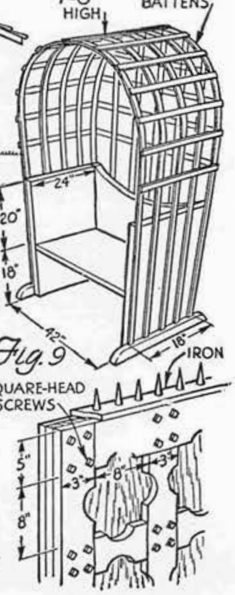
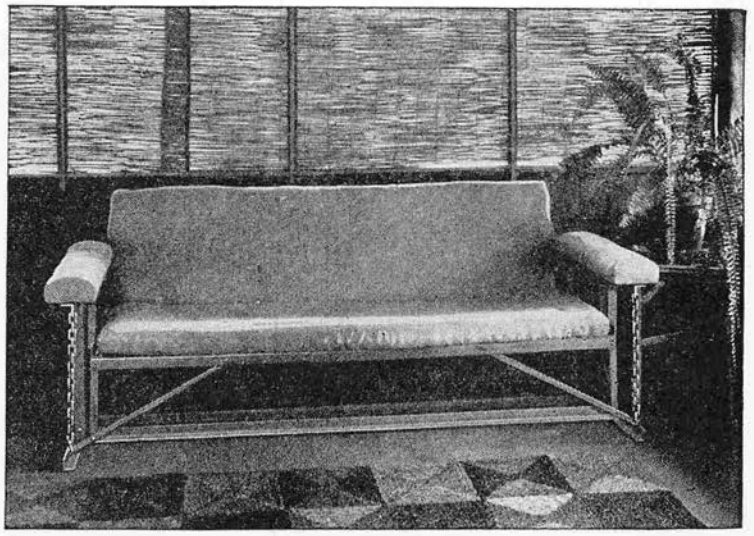


Fig. 9

Comfortable Porch Glider

BUILT FOR TEN DOLLARS

The seat, back, and arms are a single unit suspended by chains from a framework, or cradle, made as shown in Fig. 1 below



WELL-MADE porch gliders are expensive, but a comfortable one can be constructed at home from angle iron and bar stock, a length of chain, an old cotton mattress, and the link springs from a discarded cot. A coat of light green enamel and slip covers of light orange completed the glider illustrated, and the total cost was slightly under ten dollars.

For the seat and back frame, 1¾-in. angle iron is used, and for the cradle and arm supports, 1½-in. After the angle iron has been obtained, it should be cut into the following lengths: 1¾-in. angle—3 pc. 73 in. long, 2 pc. 24 in. long, and 2 pc. 19 in. long; 1½-in. angle—2 pc. 32 in. long, 2 pc. 79¾ in. long, 4 pc. 21 in. long, 4 pc. 25 in. long, 2 pc. 8 in. long, and 4 pc. 11 in. long.

Some ½ by ½ in. solid iron is desirable for leg bracing and also for the support upon which is mounted the chain by which the swing is hung—4 pc. 25 in. long, and 4 pc. 15 in. long. The chain should have links about 1¼ by 1¾ in., and should be cut into 4 pc. 18 in. long.

Mount and bolt the two 79¾-in. pieces to the 32-in. end pieces as indicated in Fig. 1. Use ¾ by 3/16 in. stove bolts for the assembly. Next bolt the two 21-in. uprights to each end and surmount these with the two 25-in. pieces, one at each end.

Next, assemble the frame for the seat. Mount the two long members, angle edge down, and the end members, angle edge up, as indicated. Measure the mesh of the cot springs and drill holes around the frame to accommodate the small hook springs. Mount the springs within this frame and attach the legs and leg supports as in Fig. 2. Although it is necessary to brace the legs from both angles, this not required in building the cradle.

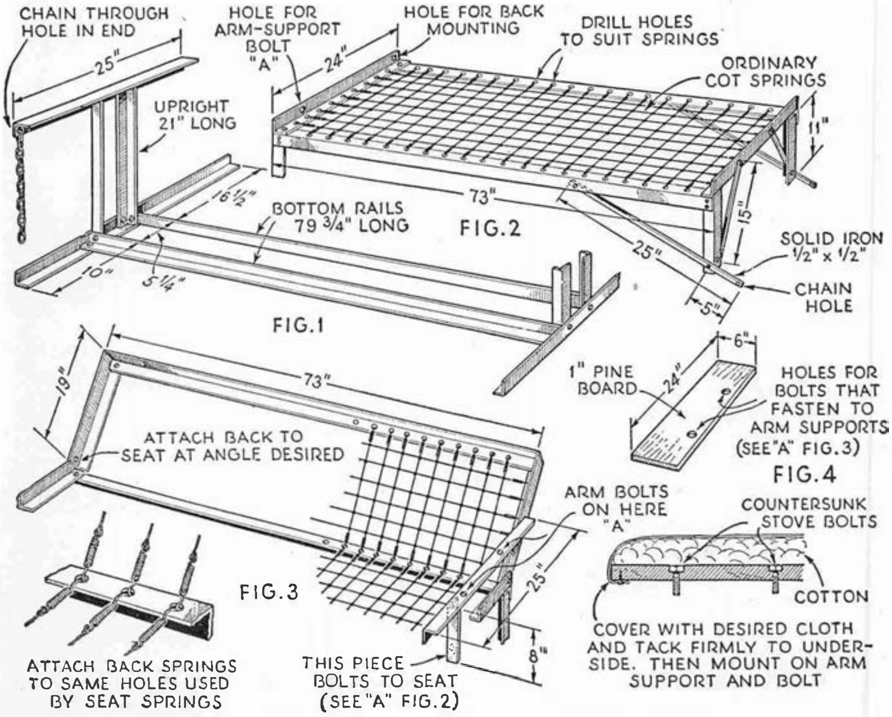
After the seat has been assembled, proceed in a similar manner with the back. All the angles on the frame for the back point in toward the seat. If the back is set properly into the seat frame and bolted on at the proper angle, no bracing need be done. Next insert the springs into the back frame. Hook the springs along the bottom edge into the same holes as were used in the seat for the seat-hook springs.

Put the arm supports in place and set the entire assembly in the cradle, suspending it with the four lengths of chain. Cut the end links on each chain and spread into hooks; then attach to the holes indicated in Figs. 1 and 2.

The arms are made of any available wood, with holes drilled to match those indicated in Fig. 3. Countersink the bolts to prevent turning, apply sufficient cotton padding, and cover with the desired fabric. This cover should be tacked firmly to the underside and the edges sewed shut with the ordinary type of baseball stitch. After completing the arms, mount them in place and bolt on tightly.

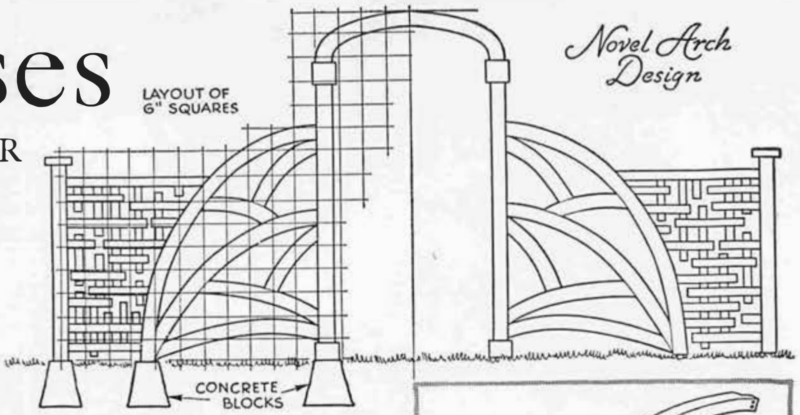
Any size mattress can be reduced to the desired size by cutting the cover, removing the excess, and resewing. The seat cushion should be 24 by 72½ in., and the back cushion 20 in. wide. The back cushion will then be 1 in. wider than the back frame, but this is to allow for contraction.

Paint the ironwork any desired color.


CHAIN THROUGH HOLE IN END
HOLE FOR ARM-SUPPORT BOLT "A"
HOLE FOR BACK MOUNTING
DRILL HOLES TO SUIT SPRINGS
ORDINARY COT SPRINGS
25"
24"
UPRIGHT 21" LONG
11"
16½"
BOTTOM RAILS 79 3/4" LONG
73"
FIG.2
15"
10"
5¼"
25"
SOLID IRON ½" x ½"
CHAIN HOLE
5"
FIG.1
19"
73"
6"
1" PINE BOARD
24"
HOLES FOR BOLTS THAT FASTEN TO ARM SUPPORTS (SEE "A" FIG.3)
FIG.4
ATTACH BACK TO SEAT AT ANGLE DESIRED
ARM BOLTS ON HERE "A"
COUNTERSUNK STOVE BOLTS
25"
FIG.3
COTTON
8"
COVER WITH DESIRED CLOTH AND TACK FIRMLY TO UNDERSIDE. THEN MOUNT ON ARM SUPPORT AND BOLT
ATTACH BACK SPRINGS TO SAME HOLES USED BY SEAT SPRINGS
THIS PIECE BOLTS TO SEAT (SEE "A" FIG.2)

How the cradle and seat proper are constructed. The dimensions may be modified if desired

New Trellises
TO DRESS UP YOUR GARDEN

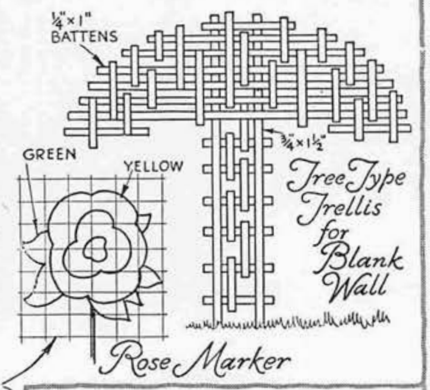


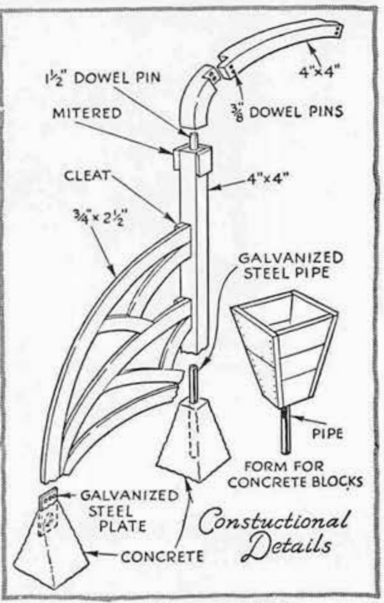
LOOK around your garden this spring and see if one or more new trellises would not improve it greatly. If so, here are some suggestions that may help you work out something at once original and decorative. These designs are a departure from the familiar rectangles, squares, and compass curves of ordinary commercial trellises.

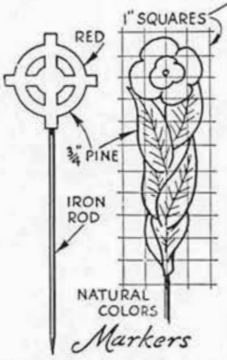
White pine is an excellent wood to use, especially for scroll-sawed pieces, because it is not likely to split and lends itself to the use of corrugated fasteners for holding butt joints. Plywood should be avoided unless of the water-resisting, casein-glued type, and even then the surfaces and particularly the edges should be thoroughly painted.

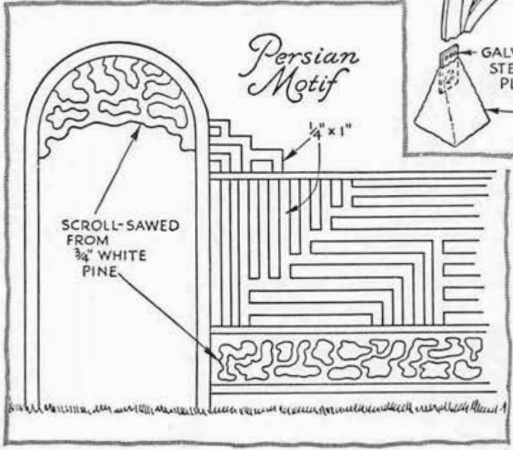
The arch design at the top of the accompanying drawings is a novel arrangement of curved pieces cut from white pine, with an irregular pattern on each side. This type, when not against a wall, can be left in the natural wood to weather. The posts will last much longer if supported on small pyramids of concrete with pipe or flat plates embedded. The concrete is poured in an inverted form as shown.

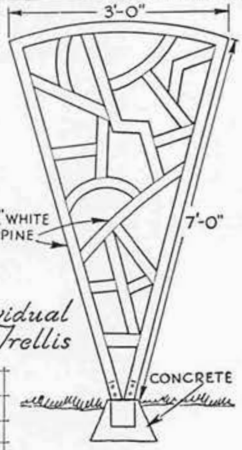
Another unusual trellis and gateway is the Persian design. The upper panels are in a basket-weave effect, built up of battens. A short piece is put behind each right-angled joint.

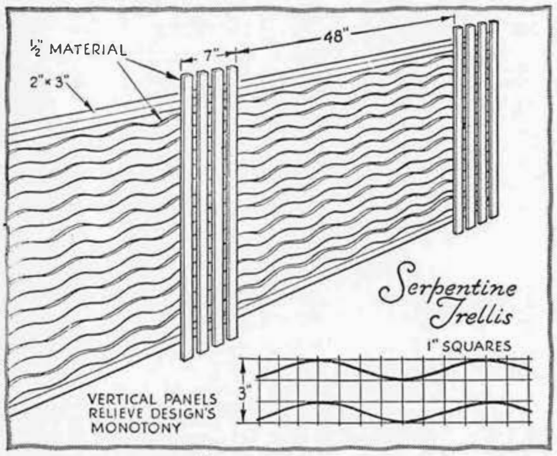


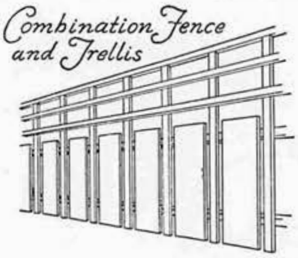


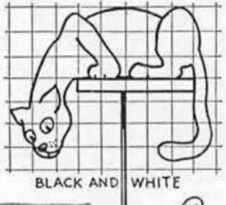


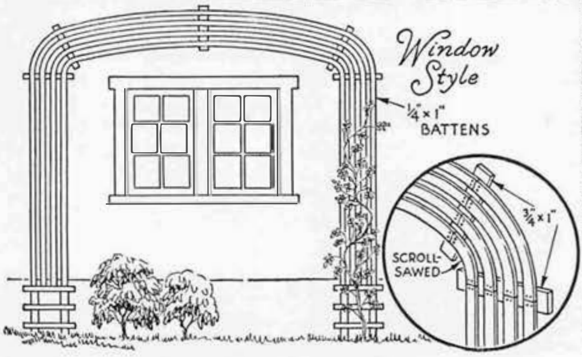


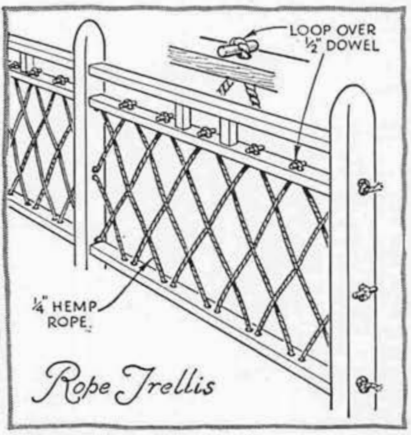


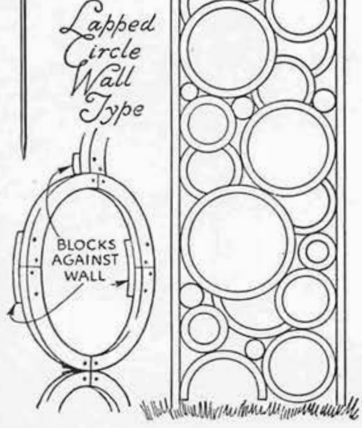






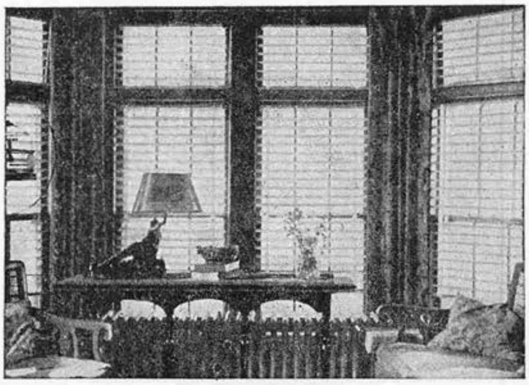






SIMPLIFIED Venetian Blinds

Add a Luxurious Touch to Any House



Sunlight partially deflected by homemade Venetian blinds

FOR rooms exposed to direct sunlight, the construction and installation of Venetian blinds will prove a valuable addition to any home.

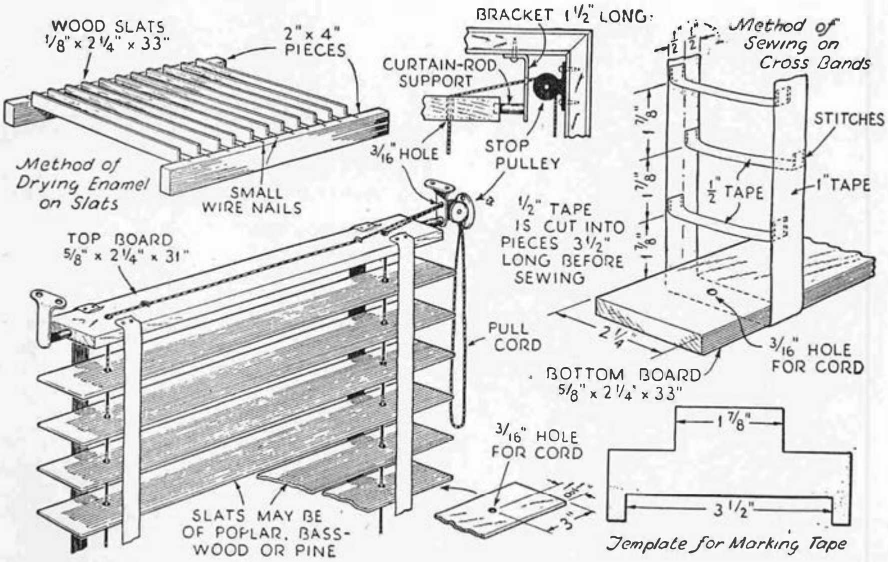
They do not interfere with ventilation through a room as ordinary roller shades do; they can be adjusted to deflect the sun's rays upward, outward, or inward; or they can be pulled into a compact parcel under the top casing.

You will need a quantity of ½- and 1-in. linen tape; cord for raising and lowering the blinds; a pair of curtain-rod holders to serve as the pivot bearings, and a pair of elbow brackets for supports and friction adjustments. Cord holders can be devised in many ways, but probably the most economical is the use of spring curtain-rod supports, the clips being bent out slightly to furnish a grip on the cord when under tension. "Stop pulleys," however, may be purchased which bind the cord. Estimates for the number of wooden slats can be figured from the list on this page.

It is of prime importance that your blind stock be perfectly straight. Basswood, poplar, or pine may be used, but it should be resawed before it is kiln-dried, then dressed and sanded. Wood that has been kiln-dried before being sawed into strips will usually warp. Old birch, which has had plenty of air-drying, may be resawed satisfactorily as a general rule. To prevent later chipping of the enamel, all edges of the slats should be carefully sanded round.

Now paint the slats with the best quality of undercoater and enamel (to avoid blistering in the hot sun). All painting should be done before the strips are bored to eliminate paint "runs," and the pieces set aside to dry as shown.

Cut the 1-in. linen tape into pairs of the required length for each window, leaving a little surplus at the ends to be tacked out of sight on the upper side of the toppiece. At the exact center of the tapes, mark off a section in pencil 3⅝-in. wide (the bottom wood piece is later tacked here). Commencing each way from these two marks, pencil a line every 1⅞ in. for each cross tape, and an extra space as a marker for the toppiece. Now mark the ½-in. tape into 3½-in. sections and make a pencil mark ½ in. inside the ends of these sections as guides for the sewing. Then cut this tape into 3½-in. sections, which are the crosspieces between the loop of the 1-in. tapes. The tapes can be easily marked if they are thumb-tacked to a drawing board and a template is used such as that illustrated.



How slats are held for drying; general method of assembly; arrangement of tapes; and other details

List of Materials

For average window with inside casement measuring 34 by 52 in.

No. of Pieces	Description	Dimensions
1	Toppiece	⅝ by 2¼ by 31 in.
1	Bottom piece	⅝ by 2¼ by 33 in.
24	Slats	⅛ by 2¼ by 33 in.
1	Pair curtain-rod supports and brackets. Brackets to be	1½ in. long
2	Linen tape	1 in. wide, each 100 in. long
48	Linen tape	½ in. wide, each 3½ in. long
1	Nontwisting curtain cord	130 in. long
1	Stop pulley or small pulley and cord holder	
	Undercoater and enamel, best grade	
	Upholstery tacks (1 package)	

Approximate cost, $1.30 to $1.50.

On the sewing machine sew one end of each 3½-in. section (laying each small piece of tape in the same direction) onto the 1-in. tape, every alternate crossband being on the opposite edge of the wider tape. Leave the last mark and the two center marks unsewed. Then fold the other end of the 1-in. tape over and sew the loose ends of the cross-bands to it at the respective pencil marks, being sure that each is on the proper edge and lies in the opposite direction from the first sewed end. When completed, you should have a loop, open at the top end, and held together by crossbands 1⅞ in. apart. Tie the ends of the sewing thread in a double knot to prevent pulling out.

The wooden toppiece should be cut 2 in. shorter than the balance of the blind to allow for the hardware. After the painting has been done, attach the curtain-rod holders to the ends of these pieces.

Now take the brackets and carefully mold their rod supports around the rod holders so that they will fit tightly; this provides for friction adjustments later. Be sure the brackets are sufficiently long, at least 1½ in., or you will not be able to close the blinds entirely. Close to the elbow of the right-hand bracket, near the top of the free side, drill a 3/16-in. hole

Any adjustment of light may be obtained by raising, lowering, and tilting these blinds

Variously adjusted blinds. They give better ventilation than ordinary roller shades

to guide the cord into the pulley, and file the edges smooth.

The next step is boring of the stock for the cord controls. In commercial blinds, it should be noted, the cords pass through slots 3/16 by 1 in. or larger. These are to allow the slats to be turned to a nearly vertical position. However, plain holes are quite satisfactory. Carefully match the required number of slats and two end pieces edgewise and lengthwise, and bore a 3/16-in. hole through the entire set approximately 3 in. from each end and 1⅛ in. from each edge. Enlarge the holes on the underside of the bottom piece to a depth of ¼ in. to enable countersinking the knotted end of the control cord. The edges of the holes on the upper side of the toppiece should be chiseled down and sanded to prevent excessive wear.

JACK the open ends of the tape loops to the upper side of the toppieces from opposite sides, centering on the bored holes but not overlapping them. Somewhere in your shop set up two hooks from which to hang this preliminary assembly. Insert the bottom piece and center it between the first two pencil marks. Now insert your slats across each crossband.

Feed both ends of the control cord up through the pulley and through the hole in the bracket; then thread each end separately downward through the two holes in the toppiece. It will be easier to do this if you bind the two ends of the cord with thread to prevent unraveling. Feed the cord ends directly down through the middle of the slats and alternately on the inside of one cross tape and the outside of the next one, continuing through the bottom piece. This will hold the slats in their proper positions without side slip. If desired, the ends of the cord may be slipped through ordinary shirt buttons and knotted, or large knots may be tied in the ends to prevent them from pulling back through the bottom piece. After the cord controls have been put in place and the buttons countersunk, tack the bottom piece in place with white upholstery tacks.

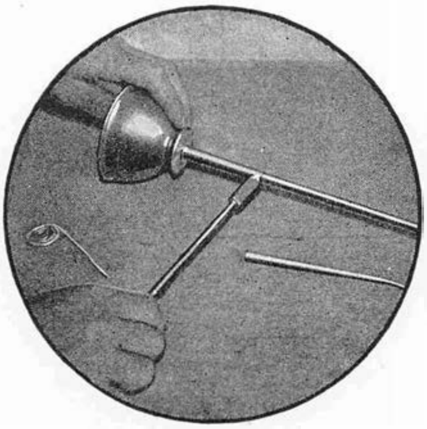
Slip the brackets on the curtain-rod supports and screw them to the underside of the top section of the window casing, keeping the blinds flush with the front edge of the casing. Install the pulley in the corner of the right-hand casing, centered on the hole in the bracket. If a stop pulley is not used, a cord holder must be mounted on the inside of the casing below the pulley near the bottom of the window.

These blinds are of the simplest construction and therefore must be adjusted to the desired angle by grasping the bottom piece.

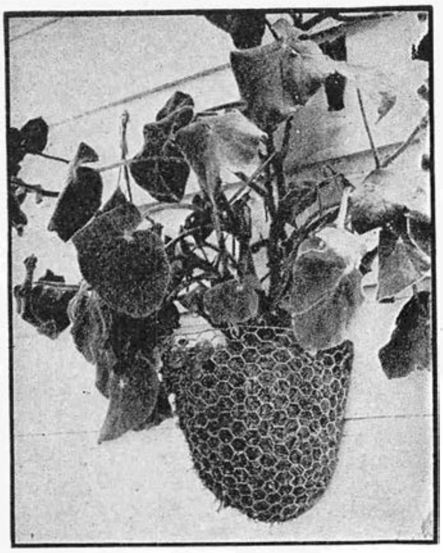
KILLING LAWN WEEDS WITHOUT STOOPING

CUTTING or pulling such objectionable weeds as the dandelion from a lawn usually does more harm than good. Unless the entire plant is killed or removed, the root will only spread, and two weeds will come up where one grew before. An easy way to eradicate these weeds is by killing them with gasoline by the method illustrated above.

An ordinary oil can is used, the spout being cut in two and a length of copper tubing from an old automobile gasoline line soldered in. It is then a simple matter to walk about the lawn and, without stooping, to apply a few drops of gasoline to the crown of each weed. After one or two applications, most of them will turn black and die.



The applicator is made by soldering copper tubing to the cut-off spout of an oil can

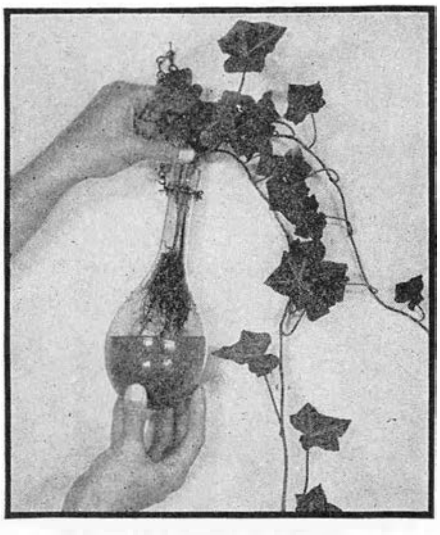


FLOWER BASKETS HANG FROM GARAGE WALL

GARAGE walls are often painfully blank in appearance, but this can often be remedied by putting up three or four hanging flower baskets, made of fine mesh chicken wire as illustrated above. The wire can be tacked to a backboard of suitable size and shape, or the basket may be made entirely of wire and attached to the wall by means of a cleat at the top. In the latter case, see that the basket is held well away from the wall so that the paint will not become streaked below.

Line each basket with a layer of moss and fill the cup thus formed with rich soil.

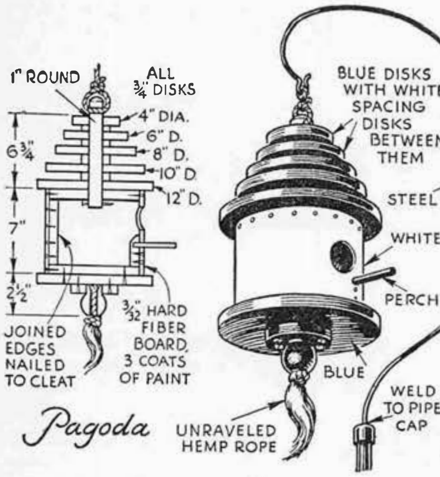
ANTIQUE BOTTLE HOLDS GROWING IVY PLANT



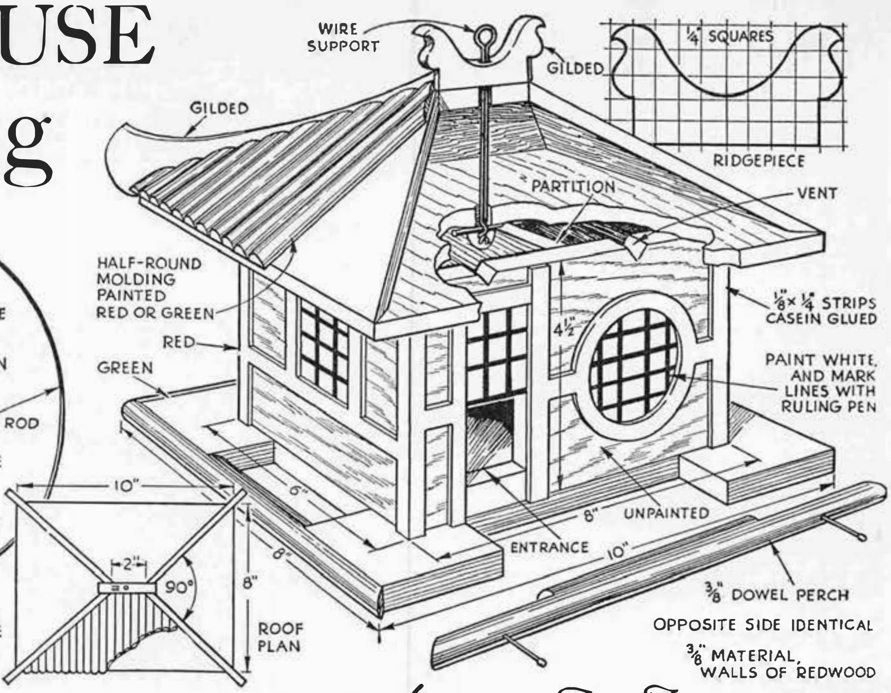
AN OLD-FASHIONED one-pint demijohn of the round-bottom variety makes an antique-looking and exceedingly picturesque wall receptacle for an ivy plant. Bottles of this variety are found in many homes or may be purchased at most antique shops for about half a dollar. Fasten one end of a brass chain tightly around the neck of the bottle and form a loop in the other end of the chain.

Place in the bottle an English ivy with most of the soil removed from the roots, or any indoor plant that will thrive in water. Fill the bottle with water and hang it in the sunshine on the window frame in the living room or in the sun parlor.

BIRD-HOUSE Building


1" ROUND
ALL ¾" DISKS
4" DIA.
6" D.
8" D.
10" D
12" D.
6¾"
7"
2½"
JOINED EDGES NAILED TO CLEAT
3/32" HARD FIBER BOARD, 3 COATS OF PAINT
BLUE DISKS WITH WHITE SPACING DISKS BETWEEN THEM
STEEL ROD
WHITE
PERCH
BLUE
UNRAVELED HEMP ROPE
WELD TO PIPE CAP

Pagoda

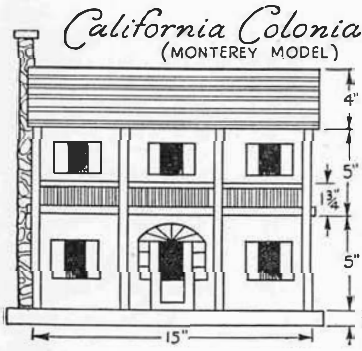


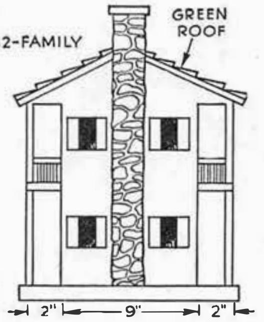
OPPOSITE SIDE IDENTICAL

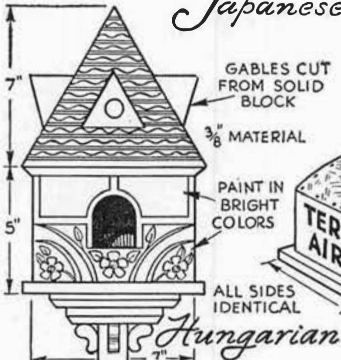
⅜" MATERIAL, WALLS OF REDWOOD

Japanese Two-Family

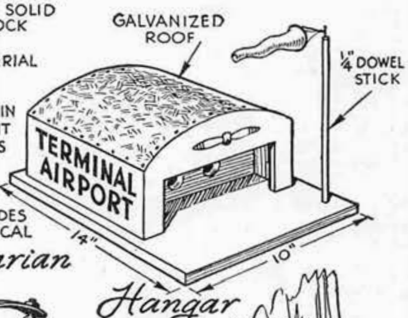
California Colonial
(MONTEREY MODEL)



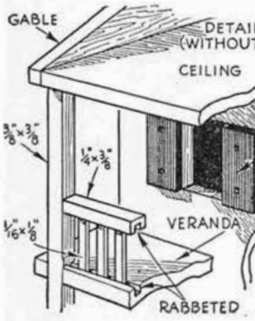


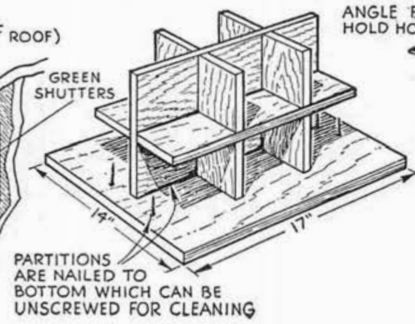


Hungarian

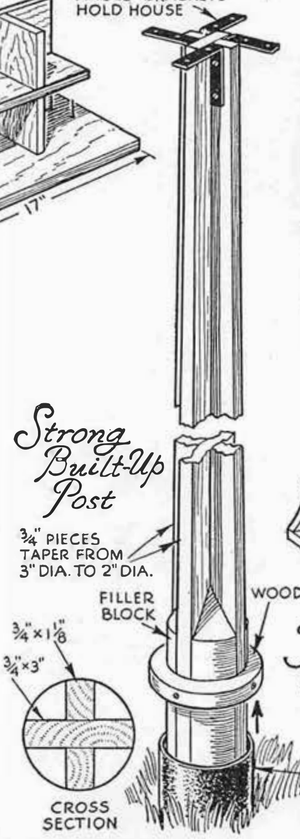


Hangar





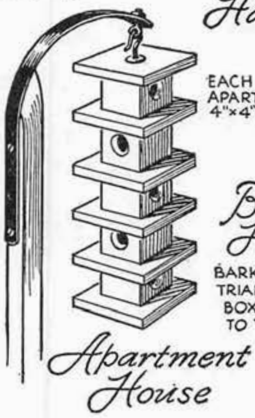
PARTITIONS ARE NAILED TO BOTTOM WHICH CAN BE UNSCREWED FOR CLEANING



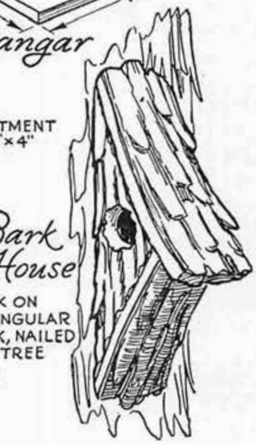
Strong Built-Up Post

¾" PIECES TAPER FROM 3" DIA. TO 2" DIA.

POST CAN BE LIFTED FROM IRON PIPE SET IN GROUND

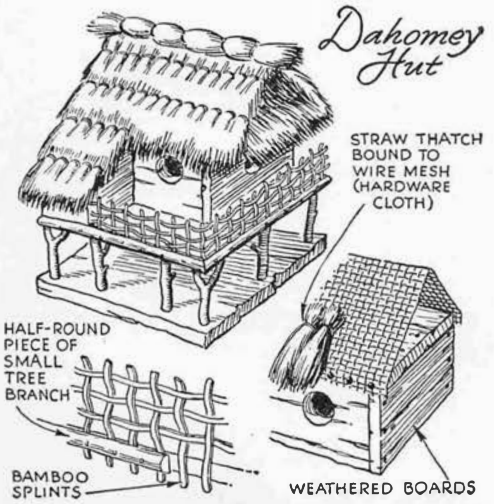


Apartment House

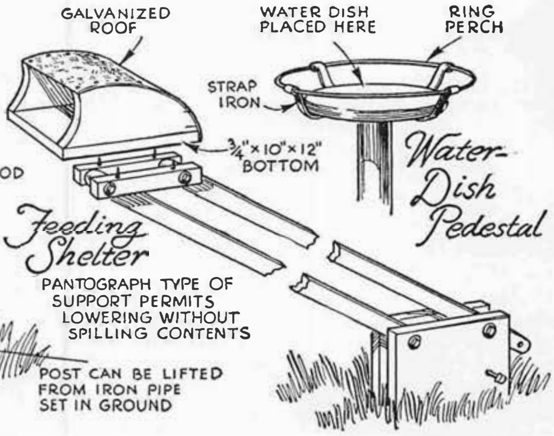


Bark House

BARK ON TRIANGULAR BOX, NAILED TO TREE


STRAW THATCH BOUND TO WIRE MESH (HARDWARE CLOTH)
HALF-ROUND PIECE OF SMALL TREE BRANCH
BAMBOO SPLINTS
WEATHERED BOARDS

Dahomey Hut



Water-Dish Pedestal

Feeding Shelter

PANTOGRAPH TYPE OF SUPPORT PERMITS LOWERING WITHOUT SPILLING CONTENTS

A PAGE OF IDEAS TO HELP YOU BUILD

GARDEN FURNITURE

ANY enterprising home landscape gardener should be able to select from this assortment of outdoor furniture two or three pieces well within his ability to construct. Figure 1 is a simple garden seat that requires only hammer, saw, and square to build; and only two-by-four's and ¾ by 3-in. material are required, preferably Southern pine if the piece is to be painted. The same size material is used in Fig. 2, with the exception of the table top, which is made up of four ¾-in. boards. Figure 3 is a coffee table, and Fig. 4, a curved Grecian bench. The top of the latter should be about 1½ in. thick. All these pieces are best painted white. Extreme simplicity is the feature of the comfortable reclining chair shown in Fig. 5. A filigree table and chair appear in Figs. 6 and 7. Figure 8 is a couch, designed to have cushions.

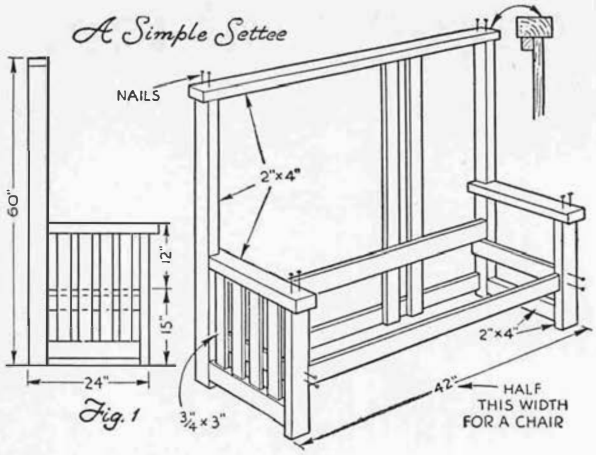

A Simple Settee

Fig. 1

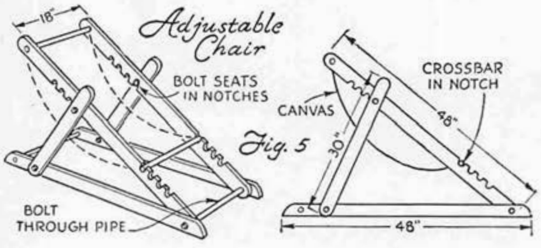

Adjustable Chair

Fig. 5

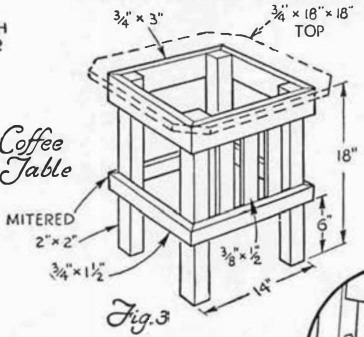

Coffee Table

Fig. 3

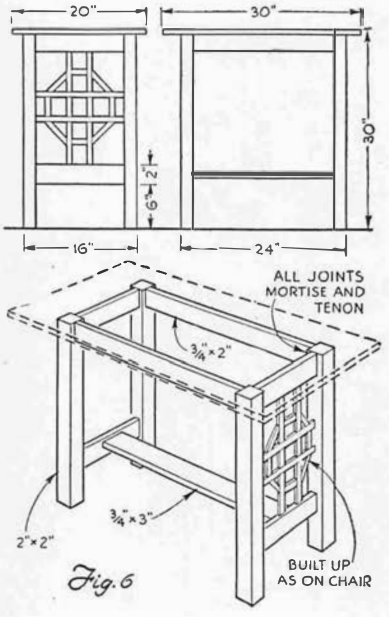


Fig. 6

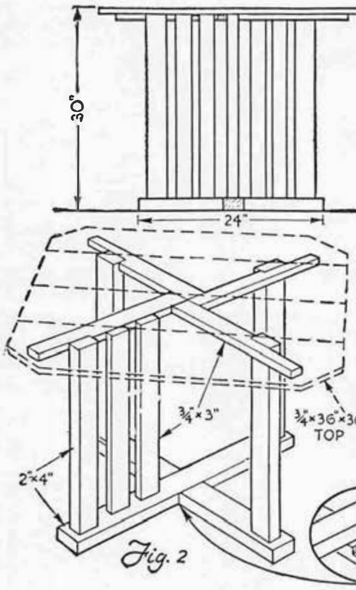


Fig. 2

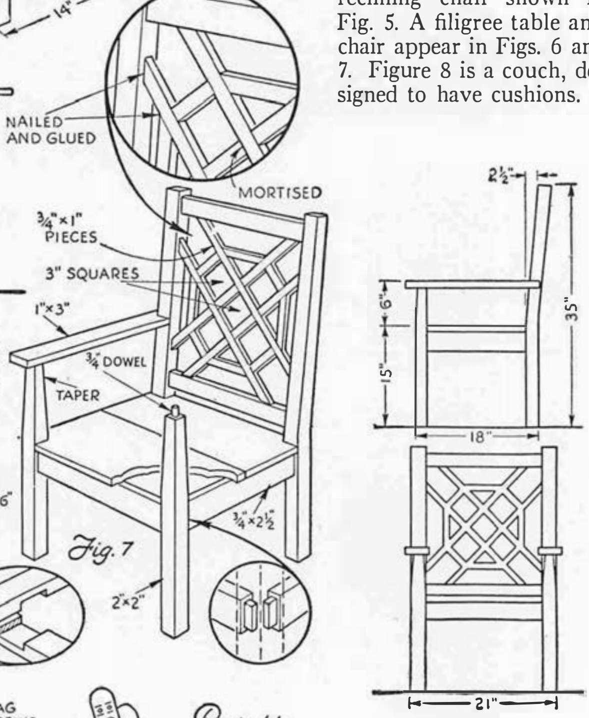


Fig. 7

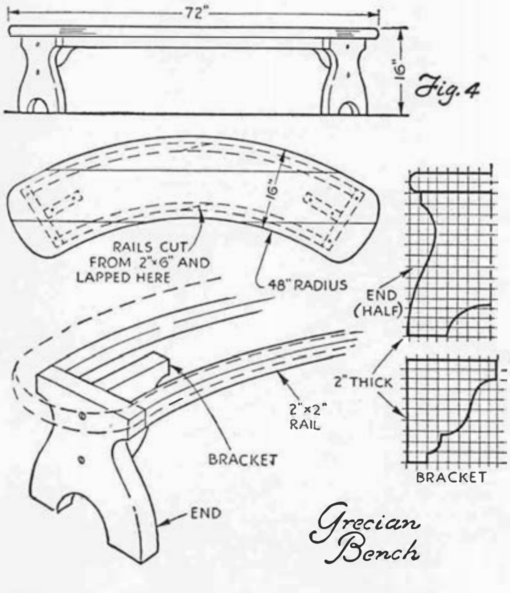


Fig. 4

Grecian Bench

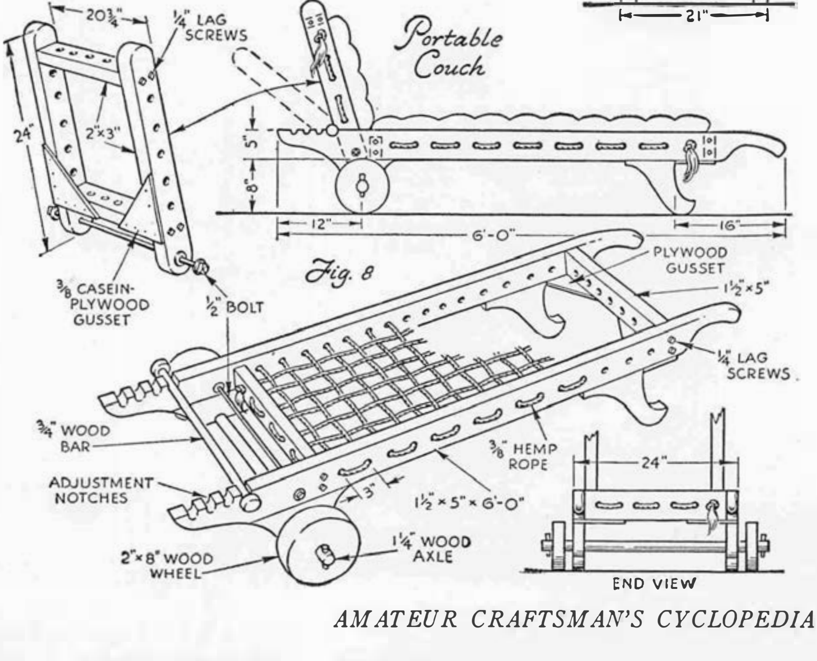
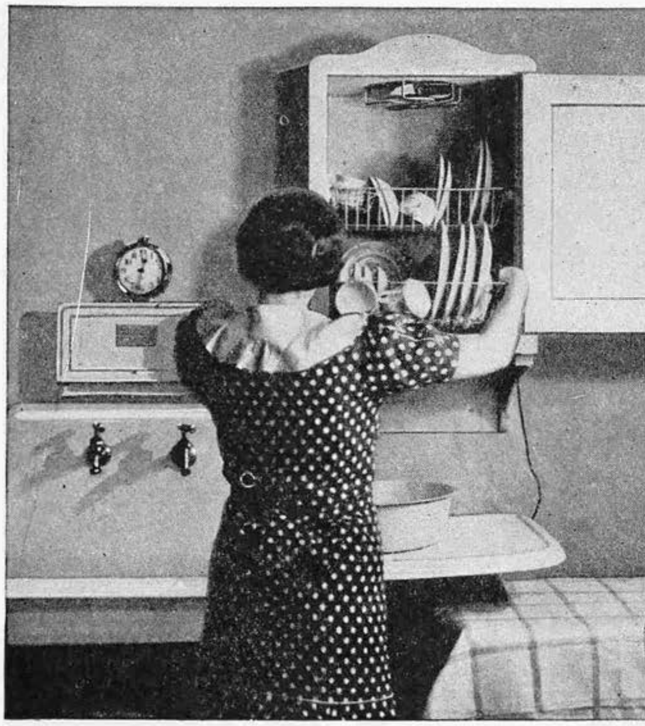
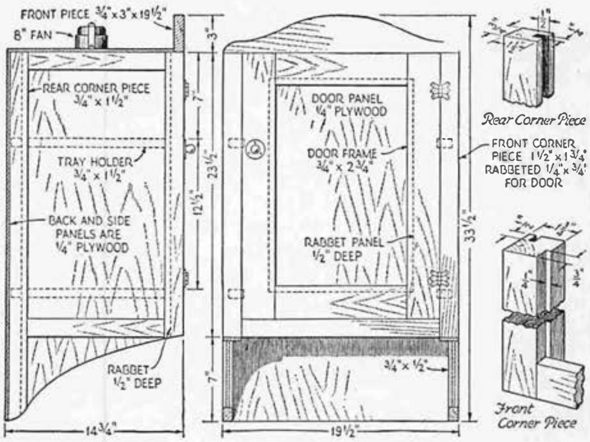
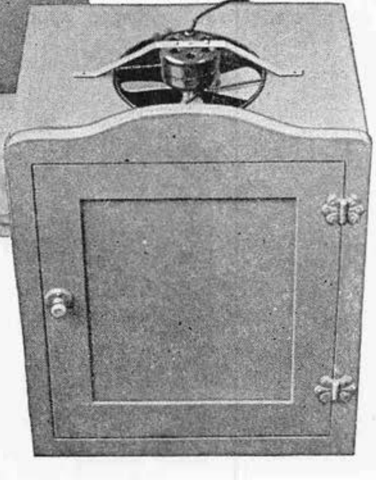

Portable Couch

Fig. 8

Easily Built Dish-Drying Cabinet







When washed and rinsed, the dishes are stacked in trays, placed in the cabinet, and dried by turning on the fan for a few minutes

THE task of wiping dishes dry may be eliminated and many steps saved by building a drying cabinet like that illustrated. It is especially adapted to small kitchens where there are no built-in cupboards or where the pantry is not easily accessible.

The dishes are washed in hot soapsuds, rinsed in clear hot water, and stacked in wire trays, which slide into the cabinet. The door is then closed and the fan plugged in for about five minutes. After being dried in this manner, the dishes may be left where they are until the next meal.

The dimensions given are for standard wire drainers 4 by 12 by 16 in. Two are sufficient to hold all the dishes and silverware necessary for a family of four or five. White pine or other softwood is used for the framework, and ¼-in. fir plywood or composition board for the panels and back. The bottom of the side panels are sawed to the shape shown to make a neat finish. The rabbets in the front and rear corner pieces are coated with glue, preferably casein, the panels are slipped in, and each side assembly is laid aside until dry. Pieces of plywood 1½ in. wide are then nailed on the sides with finishing nails to simulate a paneled effect. A piece of plywood ¼ by 30½ by 19½ in. is nailed to the back, and the top is a piece 19½ by 14 in., set ¾ in. back from the front edge of the cabinet.

Before the top is attached, the hole for the fan blades and guard should be cut. The piece for the front at the top is shaped approximately as shown and nailed to the corner pieces. The bottom of the cabinet is left open for drainage.

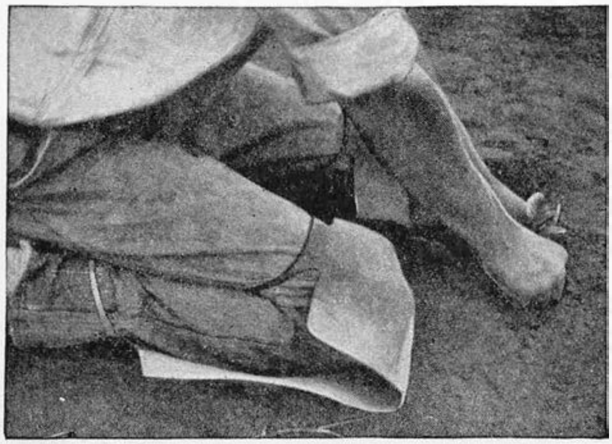
The door frame is made as shown and attached with two butterfly surface hinges or ordinary butt hinges. A latch of any desired type completes the door hardware.

Tray holders ¾ by 1½ in., or wide enough to support the edges of the wire baskets, are fastened from the outside at the points indicated with 1½-in. No. 8 flathead screws.

An inexpensive 8-in. electric fan, with base removed, is fastened in the hole previously cut in the top with a ⅛ by ½-in. strip of flat iron or brass. This is fastened to the motor and the top of the cabinet with machine screws as shown in the drawings and in the photograph taken from above the cabinet.

Paint the cabinet inside and out with three coats any appropriate color. After the paint is dry, attach the dish drier to the wall with four 2-in. No. 12 flathead screws.

KNEELING PADS MADE FROM INNER TUBE



For working in the garden or, indeed, any job that calls for kneeling, these rubber pads are convenient protectors

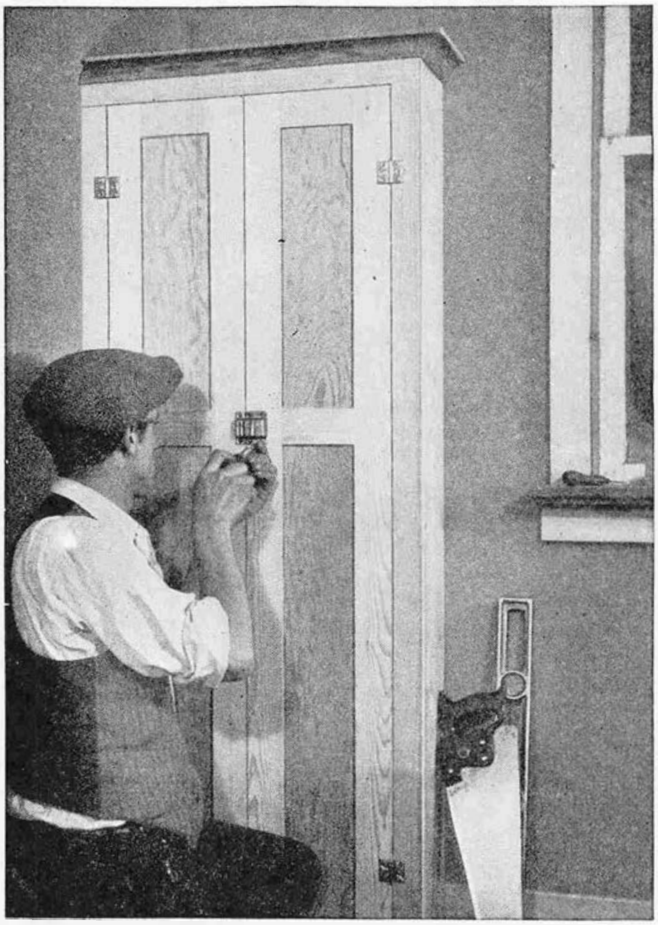
RUBBER pads to protect the clothes while kneeling on the moist earth when working in the garden can easily be made from sections cut out of an old inner tube. After two pieces have been cut to the desired length, they are slit open along the back except at either end, where a band is left to hold the pad in place on the leg. These knee protectors are easily taken on and off, are very durable, and, unlike the ordinary kneeling pad, stay where you want them.

HOW TO FASTEN NAILS FIRMLY IN PLASTER

WATER glass—the silicates of sodium or potassium, or of both—can be used successfully to make nails stand firmly in a plaster wall. There are two occasions on which it can be applied: when new holes are to be driven into the plaster, and when you must find a new way to make nails stick in holes that already have been driven—from which the plaster is beginning to crumble away. First, drive the nail into the wall, then remove it, and fill the hole with water glass. Replace the nail immediately; you will find that very soon it has become firmly fixed in its place. In the second situation, wrap the nails in cotton, soak the cotton in water glass, and then restore them to their holes. Steel wool, used in place of the cotton, and with or without the water glass, is also useful.

Paneled Cabinet

A QUICK WAY TO CONSTRUCT THEM ON THE CIRCULAR SAW



EXTRA CUPBOARDS ALWAYS USEFUL
No house has enough cupboards, but it is easy to build extra ones. When two doors are used, as in this example, the so-called "meeting stiles" are usually left full width, but in fine cabinetwork, their width is reduced for appearance

MANY owners of small circular saws do not use them to the best advantage. This is possibly due to the dearth of simple, detailed information. Upon obtaining such a machine, one is presumably expected to be able to use it.

The accompanying illustrations have been prepared to help beginners use a saw expertly and, at the same time, show how to make inexpensive paneled doors for cupboards and cabinets, since the average home seems to be forever short of cupboard space. Constructing the cupboard itself seldom offers difficulty to the average home mechanic, but making a presentable door is another matter. During the last four or five years one man has made and sold at least 300 doors of this type. Besides long since paying for the saw, his work has contributed no small sum to the credit sheet of the workshop.

A well-conditioned saw blade is, of course, essential to fast and accurate work. In order to avoid waste as much as possible, it is best to standardize on but two sizes of stock—what is commonly known as "one by six" and "one by four." These measure ¾ by 5⅝ in. and ¾ by 3½ in. approximately. The one by six, ripped down the middle, provides an excellent width for the door stiles and top rails. The one by four makes the bottom rails.

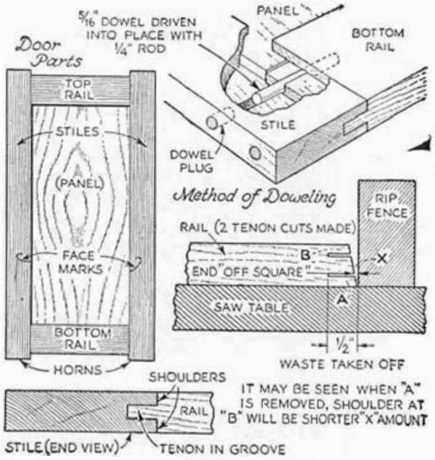
Where the finished cabinet is to be painted, the preferred wood is well-seasoned, straight-grained pine or spruce. For a moderately cheap natural or stained and varnished finish, select fir is excellent.

Assume that you are to construct a door 24 by 36 by ¾ in. Always follow the same system in obtaining measurements; this makes for fewer mistakes. The factory method is: Width first, height second, thickness last.

Cutting stiles and rails to size. The width of the side stiles governs the length of the cross rails, as will be seen by a glance at the drawing, so you must cut the former before cutting the rails to length. Cut off a piece of one by six about 38 in. long. Dress both edges square, and rip down the middle.

Place them with one dressed edge against the other and measure their combined width. They will measure about 5⅜ in. now, due to the loss by ripping and dressing. The width of the cross rails will be the door width (that is, 24 in.) minus the width of stiles (5⅜ in.) plus 1¼ in. for joints, plus ⅛ in. to allow for fitting the finished door. (In other words the door will be ⅛ in. oversize.) This sums up to 20 in. These rails are of the previously suggested widths.

Mark all stiles and rails on the face side with a face mark running toward the face edge as shown in the drawings so you will be able to determine either at a glance. This is necessary since in all the grooving and the first two tenon cuts *all material must be moved over the saw with the face side against the rip fence.* Have also a scrap piece or two to run through the various saw settings to test the



The parts of a paneled door, a simple type of tenoned and doweled joint, and an exaggerated view to show why rails must be square

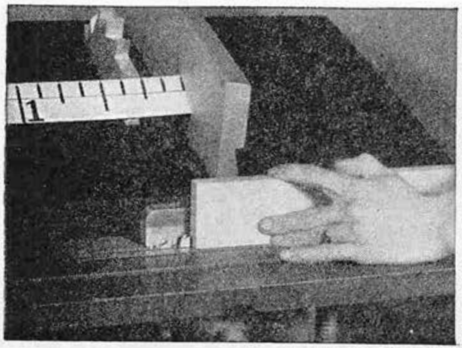


Fig. 1. The first grooving cut. The saw is set as shown by the large model in background

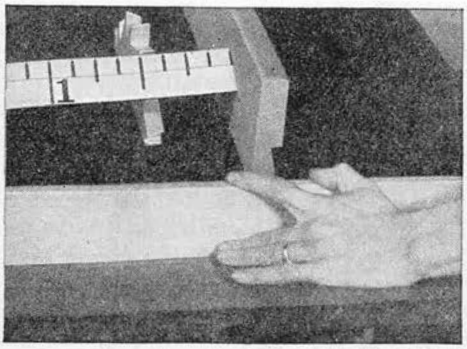


Fig. 2. Second grooving cut, with the setting again graphically illustrated by the big model

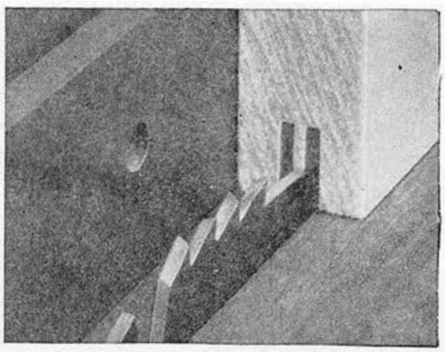
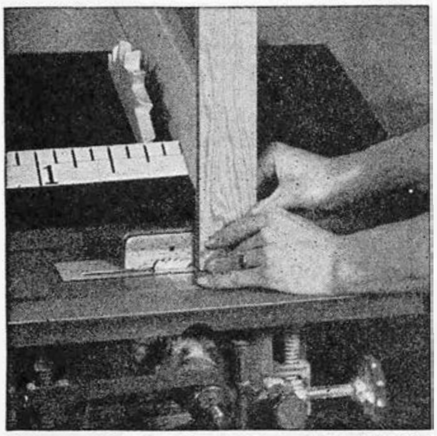
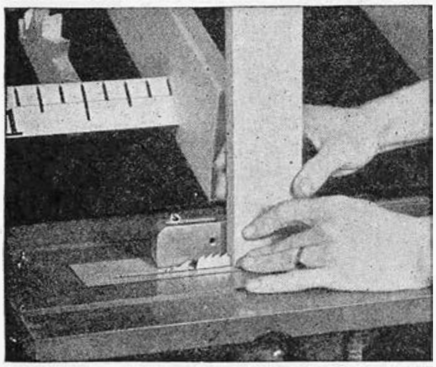


Fig. 3. A close-up of the third grooving cut. This is made to remove all the waste material.

and Cupboard Doors





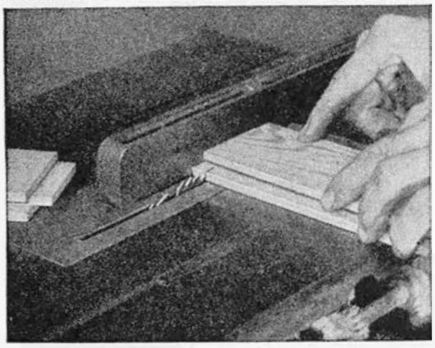


Fig. 4 (top). The first tenon cut. As the model indicates, the saw is set to "take off"

Fig. 5 (center). Second tenon cut. Be sure to test this as it governs the tenon width

Fig. 6 (bottom). Two cuts are then made at each end of the rail to form the shoulder

joint measurements and fitting. If some of these points are repeated later, it is for emphasis as they are important.

Grooving all members of frame in the face edge. Uniformity and speed of operation demand that each step be done on all parts of the door frame or frames at the time the saw is set for that particular stage of the work. This avoids continual setting and resetting of the tool and is one of the essentials of mass production.

When setting the saw for the various joint cuts, accustom yourself to the habit of mentally saying "take off" or "leave on." These terms will be used here as they lessen the number of mistakes.

To make the first cut of the groove, set the saw so that it projects through the table ⅝ in. This cut is a leave-on cut—that is, leave ¼ in. of wood intact, as shown in Fig. 1. Measure ¼ in. from the point of a tooth that is set to the right, or towards the fence; then bring the fence to this location and lock it. Run all members over the saw at this setting with the face edge to the blade and the face side to the fence. Keep them snugly in place as you slide them over the saw.

The fence is now adjusted to cut the other side of the groove. This is a take-off measure—that is, the measure is made from the tooth set to the left or away from the fence. A space of ½ in. is allowed from tooth point to fence (see Fig. 2). This cut may have to be varied to suit the actual thickness of the ¼-in. three-ply panel. It is seldom exactly ¼ in.

Adjust the rip fence now to remove the waste left in the groove as shown in Fig. 3. This may take more than one cut, depending upon the gauge or thickness of the saw blade. This leaves all members grooved.

Tenoning top and bottom rails. The tenoning is done only on the rails, so lay the stiles aside and place the former by the saw. The blade may be raised just a hair's breadth more than the previous setting so that it will cut ⅝ in. or a little oversize in depth. This is done to assure a clean corner at the junction of shoulder and tenon. Adjust the rip fence for a take-off measure of ¼ in. to the tooth set away from it (Fig. 4). Cut the test piece first, running it on end, face side to the fence, over the saw as shown. (All circular-saw work requires the utmost care to guard against accidents, and this is especially true in regard to tenoning.) Try the test piece against a groove to make sure that the tenon is going to be correctly placed.

Figure 5 illustrates the second setting for the tenon. It is a leave-on cut, ½ in. being measured from the tooth set to the right, to the fence. This cut determines the width of the tenon, so it is imperative that this cut be made on your test piece. Remove the waste from both sides with a hand saw, and try it for fit into a groove. Adjust the fence very finely, either way, till the saw cuts the tenon exactly the right width. Then run each end of all rails, as for the first cut, over the saw, with the face side to the fence.

The width of the tenons now formed, you must remove the waste and form the shoulders. Lower the blade till it will just cut through the waste without touching the tenon when the rail is laid on the table as in Fig. 6. Adjust the cut-off guide for a perfectly square cut. Then adjust the rip fence for a take-off cut of ⅝ in. Place the rail against the cut-off guide and slide endwise till it butts against the rip fence; it is now in position to be pushed across the blade.

All the shoulders are cut in this manner, but it is well to remove the waste always from the face side first. The reason is shown in an exaggerated diagram of this operation. You will see that if the rail end be slightly out of square, this procedure will leave the face side shoulder minutely longer than the back one. This assures the best fit on the front of the finished door. (Mention of such small details may appear superfluous, but if one's method of work tends to correct possible errors, it will save much time.)

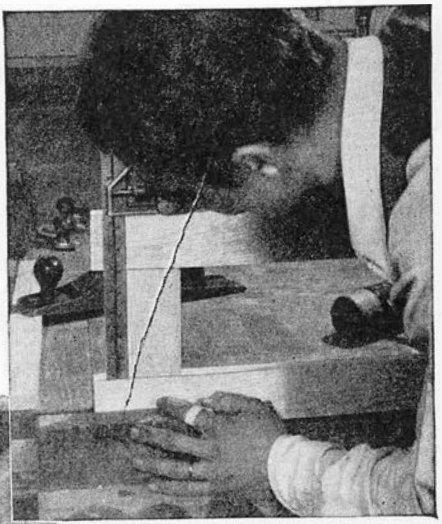
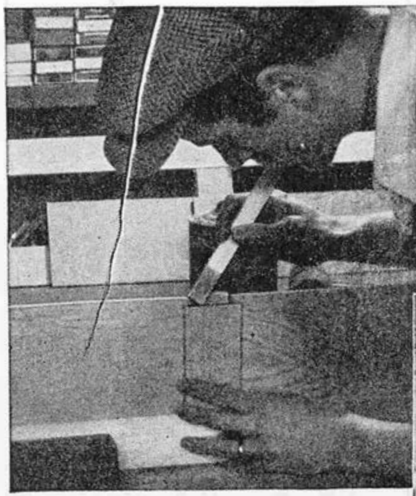


Fig. 7. When the rails and stiles have been grooved and tenoned, a trial assembly is made and all joints are closely examined for fit and squareness. At this time the frame is also measured to find the exact panel size



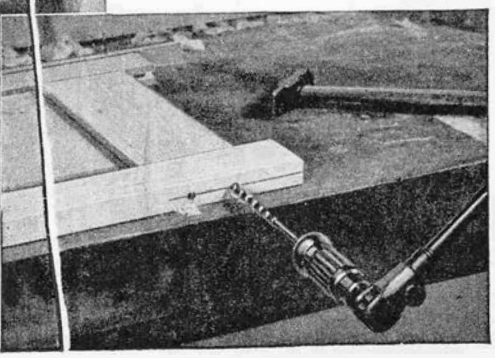


Fig. 8 (above). The door is next assembled with the panel. If all joints fit well, one stile is removed and glue is put on tenons, shoulders, and grooves. Then the stile is replaced and that on the other side treated in the same way

Fig. 9 (at right). Boring for the dowels

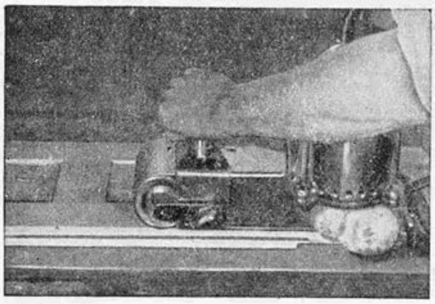


Fig. 10. Doors are sanded diagonally, then with the grain if the finish is to be natural

Assembling frame and cutting panel. Mark the length of the door on the stiles. As they are longer than necessary, a piece will be left at each end. These are the "horns," which serve to protect the door till fitted. In addition, it is well to be slightly oversize in actual length as in width because this will permit fitting the door to a slightly out-of-square opening.

Assemble the door (Fig. 7) and determine the panel size. Measure between the stiles and add 1⅛ in. to find the panel width; likewise, between the rails to get the length. This will leave the panel ⅛ in. less both ways than would completely fill the grooves. This is done to assure easy assembly of the door.

Gluing up. After cutting the panel, assemble the door completely. If all is well, place the door horizontally in the vise. Tap up and off the upper stile and apply glue to tenon, shoulders, and grooves, as well as at a point or two along the groove to grip the panel (Fig. 8). Repeat on the other side of the door. When you apply the clamps, test occasionally for squareness and avoid undue pressure.

Doweling. When the glue has set, the clamps are removed (the next day) and the stiles are drilled through the edge and into the rails as shown in Fig. 9 and the drawing. These holes are for the dowels. The dowel does not run continuously through the stile, but is cut off about 2½ in. in length and driven or set into the hole with a ¼-in. piece of rod. The exposed hole in the edge of the door is then plugged with another short piece of dowel. This is done so as to permit natural shrinkage of the stile, without either breaking away from the dowel or becoming split itself, which might easily happen if the dowel passed completely through the stile. Two dowels at each bottom corner and one at the two top corners will be sufficient. This method of placing the dowels from outside was chosen because of its simplicity.

Cleaning up. The doors are ready, after putting in the dowels, to be cleaned up. Sand all joints flush. If a bench sander is available, it will be found the ideal tool for this part of the work (Fig. 10).

It is often desirable to put in a cross rail or two, either for appearance in a long door, or to enable the use of smaller pieces of paneling. The length of such rails will be the same as the top and bottom rails, the same width as the top one, but grooved on both edges to take the paneling. These rails need not be doweled.

When two doors meet with the type of joint shown in Fig. 11, one stile must be made the width of the lap wider than the adjoining so that both stiles will show the same width on the face side when the doors are hung. In fine cabinetwork, the two meeting stiles should be reduced in width so as to appear as one stile in width; in common work, however, they are better left full width for strength. More durable and sturdier doors may be made by using material 1⅛ rather than ¾ in. thick.

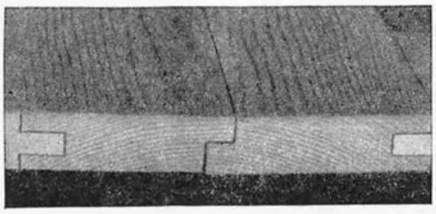


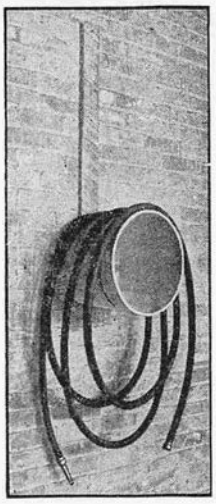
Fig. 11. When two doors meet with a joint of this type, one stile must be made wider than the other by the width of the lap so that both will show the same width from the face side when the doors are hung in place

PAPER CLIPS FASTEN WIRES TO BASEBOARD

The ordinary long type of wire paper clips make neat fasteners to hold electric cords at the top of the baseboard when it is desired to run the cords along the side of a room. Simple snap the clip over the cord and push it down between the baseboard and the plaster.

CANDY PAIL KEEPS HOSE FROM GETTING KINKED

If you have no garden hose reel, a simple and most inexpensive method of keeping the hose in good condition is to hang it on an ordinary wooden candy pail as shown. A strip of wood is nailed to the bottom of the pail so that the whole can be hung on a large nail or screw. When placing the hose over the pail, take care that the lower part of the coil does not touch the floor.



Garden hose hung on an empty candy pail

A garden hose, when not in use, should never hang over brackets or any sharp objects, as this will put kinks in it and finally cause a break at these points; neither should it be left lying on the floor or ground for any length of time.

Studio Couch Made From Old Davenport

A MODERN studio couch that will open into a comfortable bed for two people can be made from an old duofold davenport, three boards, and any suitable covering material. You can obtain an old davenport at almost any used-furniture store. Select one, if possible, of spring construction set in a wood frame. Remove the ends, the back, and all the old imitation leather on the seat. Cut a wide board—¾ in. is thick enough, or you can use old table-top boards—for each end of the davenport, so that it will be even with the front and top of the seat.

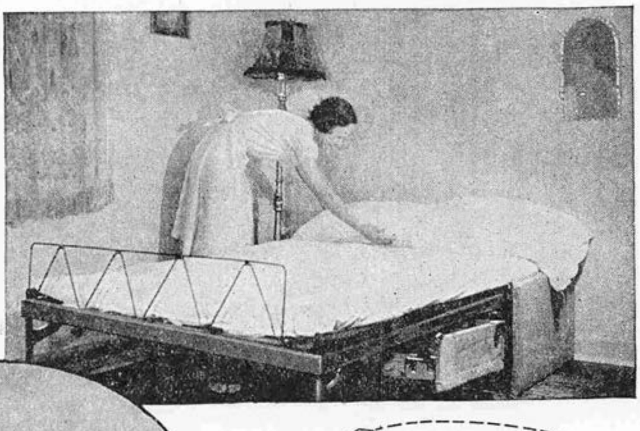
Use the old davenport end as a pattern for marking the bolt holes in the new end. This will insure the davenport's unfolding properly when finished.

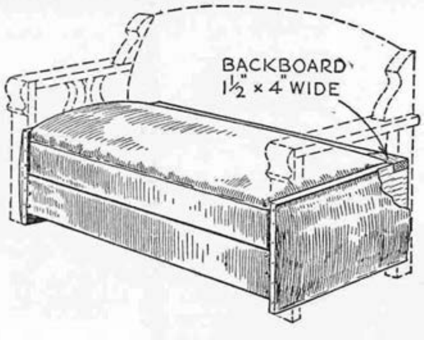
Now notch the rear top corners of the davenport ends to receive a board 1½ in. thick and approximately 4 in. wide. This is to be used instead of the old back. It covers an empty space there, helps to brace the ends, and provides a place for a spring latch to hold the seat in its folded position.

Now re-cover the seat. Cover all the way to the bottom on the front; also cover the ends and the backboard with the same material.

A comfortable bed for two persons comes out of an attractive studio couch made from an old davenport. The bed is shown at right

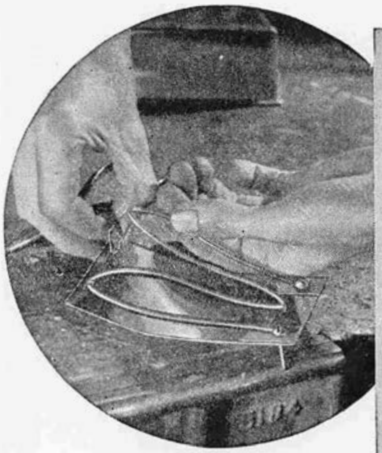
Covered with suitable material, the couch improves the appearance of any room. The drawing shows how the main elements of the davenport are used in constructing couch

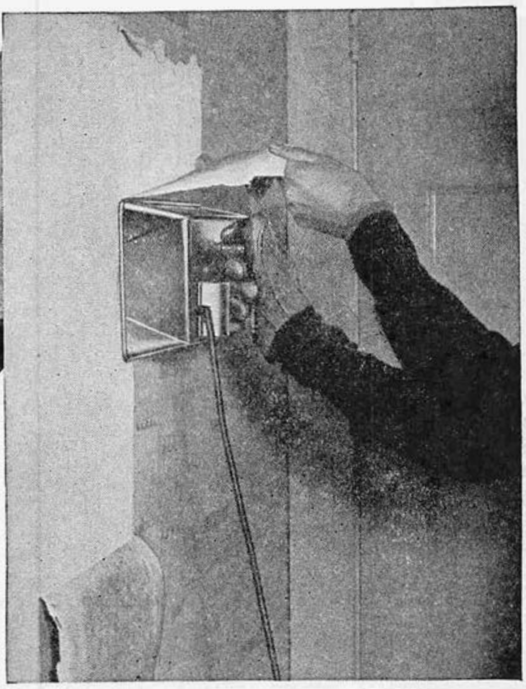




STEAM-ELECTRIC Wall-Paper Remover

COSTS A DOLLAR TO MAKE





Although this electrically operated remover is so inexpensive to make, it will steam off two layers at once

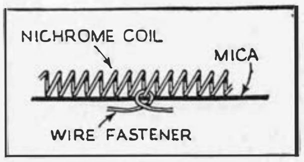
REMOVING wall paper, even if it is several layers thick, becomes a simple matter with a steam-electric remover, which any one handy with tools can build at small expense. Steam, generated in a reservoir heated by electricity, penetrates the paper and loosens the paste more efficiently than any amount of ordinary soaking with water.

The remover illustrated was assembled from baking pans and other articles obtainable at the average "five-and-ten" or hardware store. The cost was about one dollar.

Two rectangular tinplated bread pans, one considerably smaller than the other, are needed. The larger pan forms a hood for directing the steam against an area of the paper equal to the area of the open top of the pan. The smaller pan, which should be of the same relative shape, is mounted inside the larger one, after being converted into a steam generator.

This conversion involves most of the work on the remover. The heating unit consists of a length of coiled resistance wire, consuming from 550 to 600 watts of current. This is mounted so that it heats an area covering part of the bottom and part of one side of the small pan. You can purchase coiled resistance wire at any electrical store in the form of springlike replacement units for toasters and similar devices.

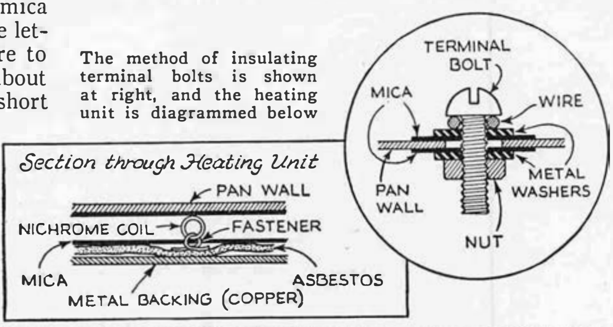
Obtain two sheets of mica, 4 by 5 in., which will cost about 15 cents each. Stretch the resistance wire slightly to separate the coils, and mount it on one of the mica sheets, arranging it in the form of the letter M, as shown. To fasten the wire to the mica, punch two small holes about 3/16 in. apart in the mica, and run a short piece of nichrome or iron wire through them, looping it through one of the resistance coils. The ends of the resistance coil are looped about small brass bolts inserted through holes drilled in the mica.



The resistance wire, shaped into an M, is fastened to the mica with short loops of wire

Bend the mica sheet bearing the resistance wire so that it fits snugly against part of the bottom and a side of the pan, as illustrated. Bend the other mica sheet the same way, so that it forms an insulating layer between the wire and the pan bottom. A piece of asbestos and a sheet of copper or tin plate serve as a backing for the heating unit. These five layers—mica, wire, mica, asbestos, and metal plate—are held in place by two clips made of heavy gauge copper or brass and riveted to the pan bottom and side. Be sure the rivet holes do not let water leak out.

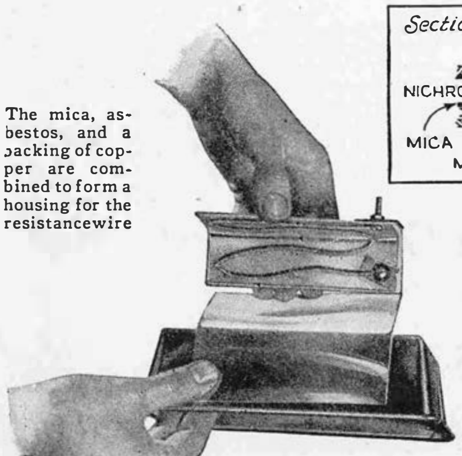
The two bolts forming the heater terminals must be insulated from the metal back plate. This is accomplished by punching or drilling holes considerably larger than the bolts and then using mica washers and brass nuts to clamp the bolts rigidly in the centers of the holes.



The method of insulating terminal bolts is shown at right, and the heating unit is diagrammed below

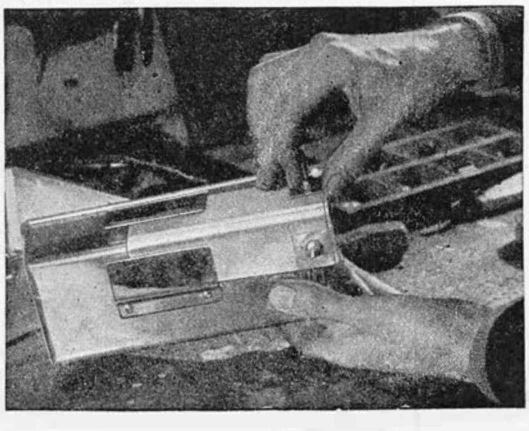
The open top of the smaller pan must be covered with a sheet of tin plate in which has been cut the hole (or holes) for the escape of the steam. The photographs show a single hole in the center of the plate, but experience has indicated that two holes, one near each end, would provide better steam distribution. Cut the holes in any convenient manner, making them about 1 in. in diameter; and then solder, to the inner surface, short tubes made by bending strips of tin plate around a cylindrical object. These tubes must be of a length slightly less than half the depth of the pan. Their purpose is to prevent water from running out when the remover is turned upside down or tilted on its side. Solder the tin-plate cover to the pan edge, making sure there are no leaks.

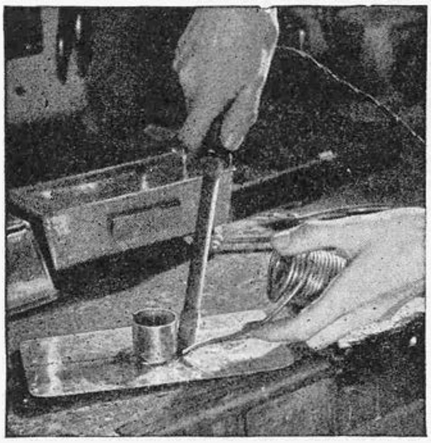
Mount the steam generator inside the large pan, placing it so that there is as much space as



The mica, asbestos, and a backing of copper are combined to form a housing for the resistance wire

The heating unit is fastened to part of the side and bottom of a bread pan by two sheet-metal clips



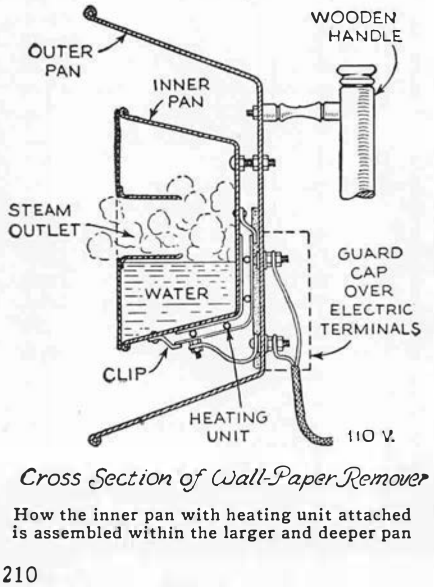


Soldering tube to cover of inner pan. Two or three smaller tubes would be even better

possible between its outer surface and the plane of the large pan edges. It is a good idea to place a layer of asbestos between the two pans, to act as a heat insulator. One of the heater-unit terminals projects through the back of the large pan, being insulated from it with mica. The other terminal is connected by means of a short piece of wire with a second bolt an inch or so from the first, and similarly insulated. Fasten the heavy-duty, flexible power-cord wires to the two bolts, and solder over them an arched piece of tin plate to prevent accidentally touching the live parts. A wooden coffeepot handle or some similar means of holding the remover, bolted to the back of the outer pan, completes the device.

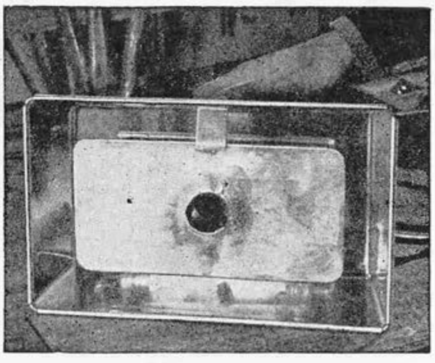
When you are ready to use the wall-paper remover, fill the steam-generating chamber with enough warm water to reach almost to the end of the tube that projects inward from the steam outlet hole or holes. The chamber illustrated holds 8 oz. of water. Set the remover on edge, with the heating coils down, and turn on the current. Steam will begin to emerge in less than two minutes.

To remove the paper, hold the device against it until the steam has had time to loosen the paste, a matter of a few seconds. Then, by moving the steamer slowly down the wall, the paper can be peeled off cleanly in long strips. Watch the water level, which you can do by looking into the steam hole or holes, and refill before all of the water has evaporated, otherwise you might damage the tool by melting the solder.



Cross Section of Wall-Paper Remover

How the inner pan with heating unit attached is assembled within the larger and deeper pan

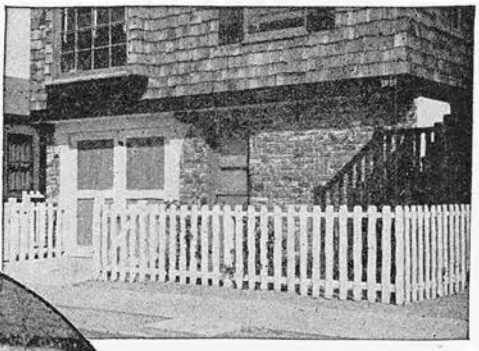


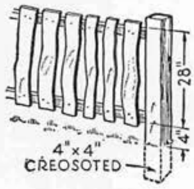
The working side of the remover. Note the sheet-metal strip used to brace the inner pan

CADMIUM-PLATED CONDUIT USED IN MAKING MODERN FURNITURE

Craftsmen who plan to build modernistic tubular furniture can save considerable expense by using the new cadmium-plated conduit now being made for electrical work. It comes in a dull finish, so take a wad of fine steel wool and go over the tubing vigorously. In this way you can obtain what appears to be almost a chrome finish, bright and highly polished. Thin, clear lacquer will preserve this finish indefinitely. Several chairs treated in this manner and placed in a local office where all other fixtures were in modernistic chrome, created much favorable comment.

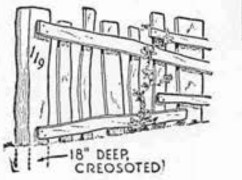
ONE OF THESE fences WILL IMPROVE YOUR PROPERTY





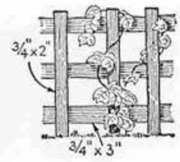
A pleasing variation of the ordinary picket fence is obtained by the use of crooked boards for the uprights

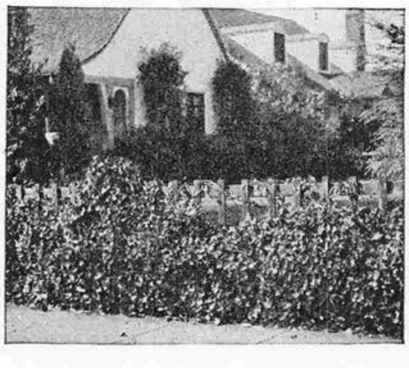
A simple picket fence with substantial brick supports. Such a fence is at home with any Colonial design. If wooden posts are used, treat the lower ends liberally with creosote

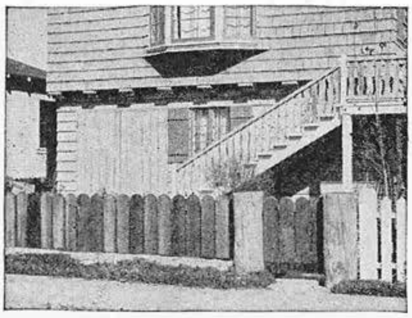


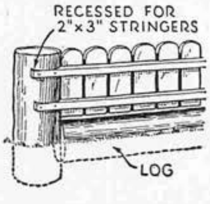
Almost any wood of odd sizes can be used for constructing a picturesque fence of this type. It surrounds a cottage on Balboa Island, Calif.

A low lattice fence is shown below, and the dimensions are indicated at the right. In this case, it acts as a trellis for English ivy, only the tops of the pickets and posts being seen







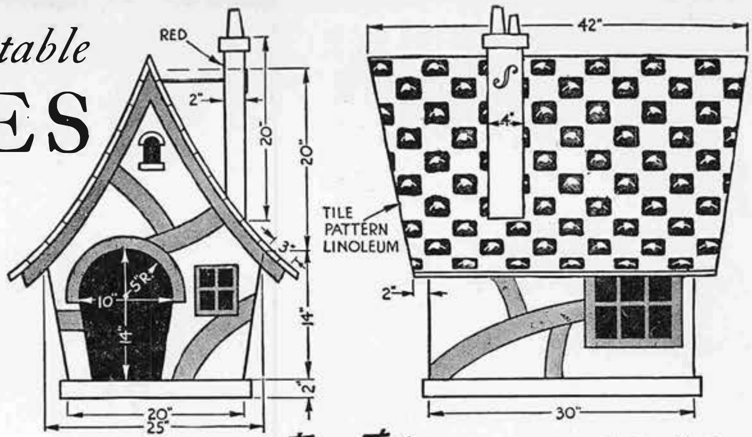


Sections cut from old telephone poles form the supports for this fence. The fence boards are of rough pine, weathered. Note the half-buried log

Seven Ways to Build Comfortable

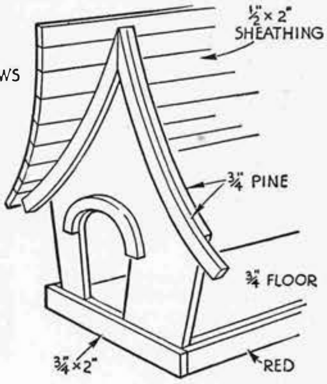
DOG HOUSES

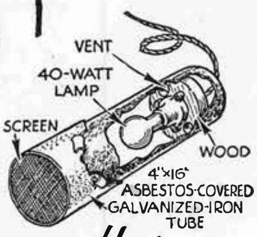
DOGS appreciate comfort so much that it gives genuine satisfaction to build good houses for them. The designs illustrated are suitable for a wide variety of conditions, and the dimensions can be adapted to the individual pet. Warmth, freedom from drafts, and cleanliness are important. For the house located out of doors, excelsior makes an excellent bed because it can be removed periodically and burned.



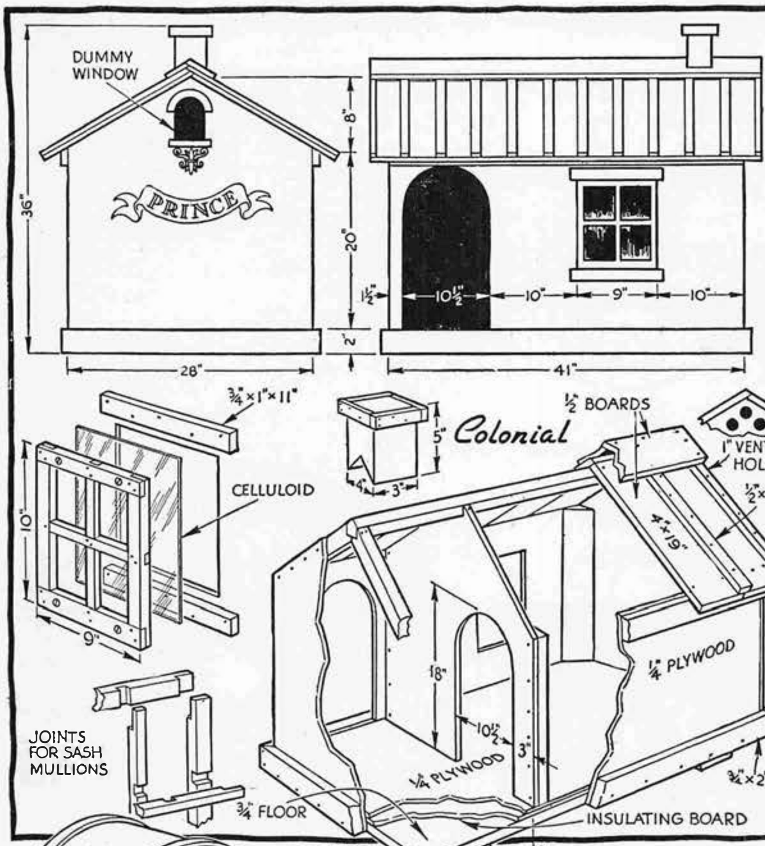
Fairy-Tale Cottage

BLACK DUMMY WINDOWS WITH GREEN FRAMES. BROWN TIMBERWORK CREAM WALLS

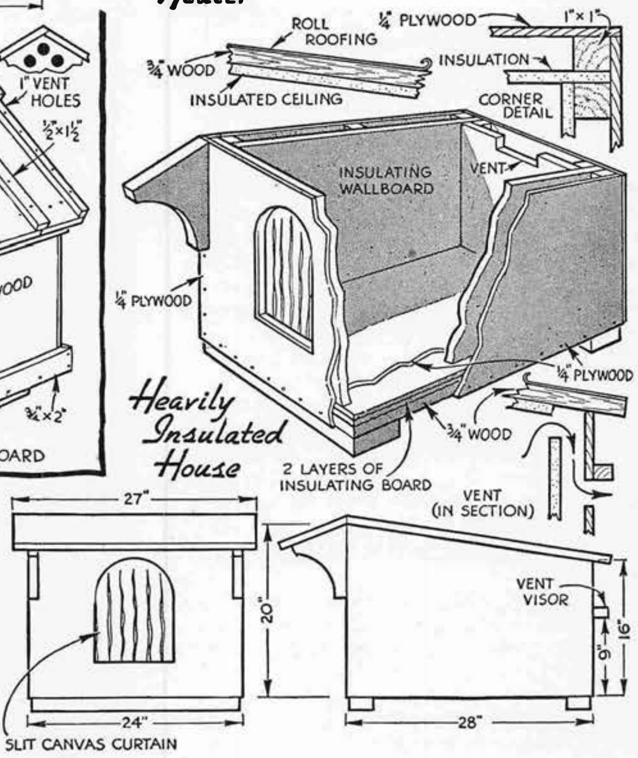




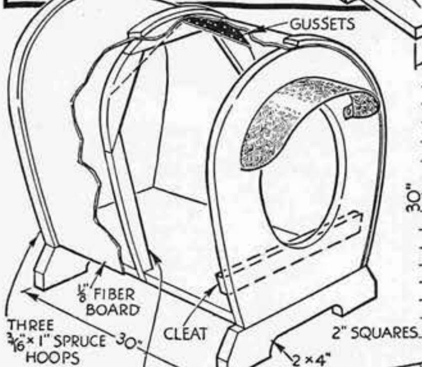
Heater

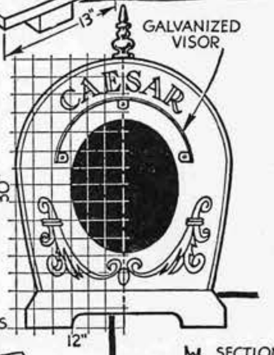


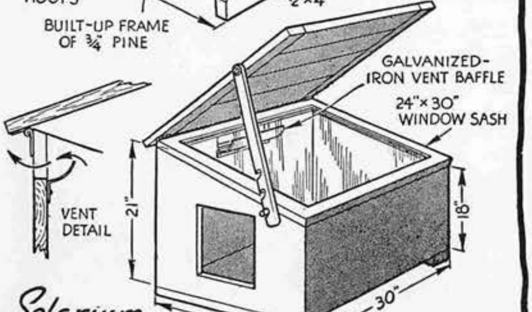
Colonial



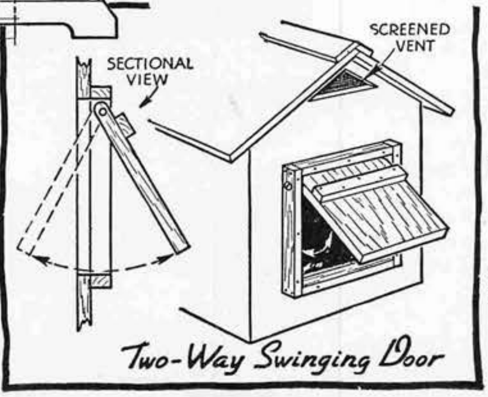
Heavily Insulated House



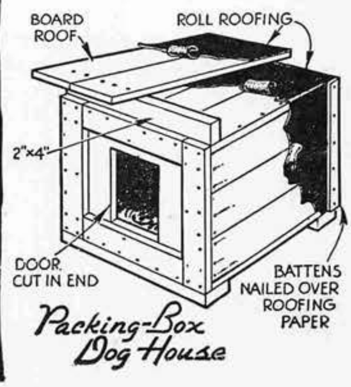




Solarium

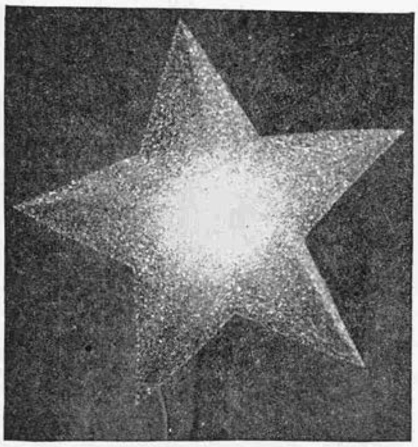


Two-Way Swinging Door

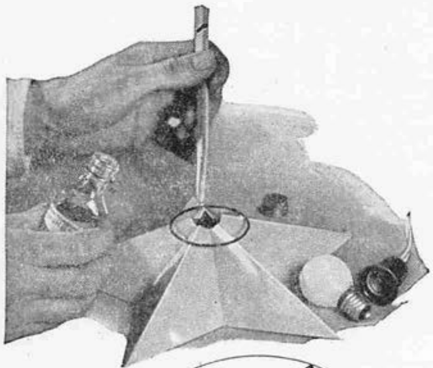


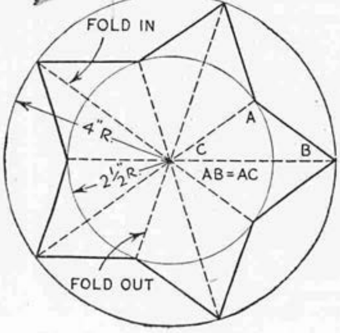
Packing-Box Dog House

New Ways to Light Your



Brilliant tinsel-covered star with a small intermediate screw-base lamp at its center. It may be used in a variety of ways





The star is cut out and folded as at the right, and a reënforcing ring is fastened to the back with celluloid cement as above

LIGHT, as produced by the electric lamp, affords perhaps the most striking and beautiful means of telling the world that you are in tune with the Christmas holiday season. To arrange an attractive decorative scheme with light is neither costly nor troublesome. The drawings and photographs on these pages serve to illustrate a number of new lighted novelties that can be built by anyone from cardboard and similar inexpensive materials. They employ lamps so small that the current consumed is negligible.

Most of these novelties are built around the S-11 Mazda lamp, obtainable in 6- and 10-watt sizes. This lamp has an intermediate screw base and a bulb diameter of 1⅜ in. The lamp is held in an intermediate screw socket of the pigtail type, with bakelite shell. Both lamp and socket can be obtained through electrical dealers, or from stores handling lighting equipment.

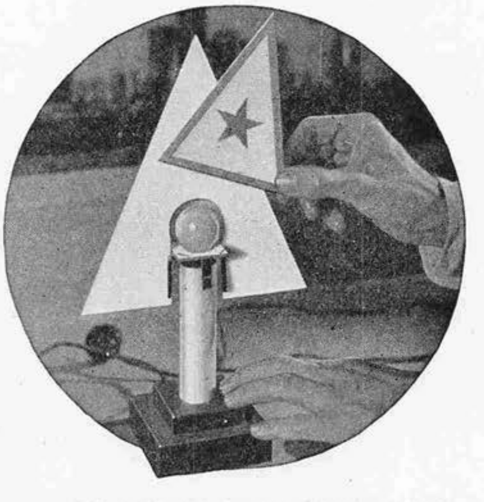
The "tinsel tree," one of the most striking of the decorations suggested here, becomes a mass of glittering jewels when alight. The effect is the same front and back, so that it can be placed in a window or in front of a mirror indoors.

The base, which can be used also for other decorations of similar design, consists of two disks or squares arranged in pyramid fashion and surmounted by a cylindrical pillar that forms the stem of the tree. The tree part consists of a hollow isosceles triangle built up of cardboard segments, which are themselves triangular in cross section. The pieces are arranged to taper from the outer edges towards the center, so that light from the bulb in the center will fall on their surfaces. Small triangles of cardboard or cardboard frames covered with translucent colored paper serve as shields to cut off direct light from the lamp. The dimensions of the various parts are indicated on the accompanying sketches. You can use any type of glue to fasten the cardboard pieces together, but celluloid cement, such as builders of model airplanes employ, is particularly desirable because it dries rapidly.

It is a bit of a trick to produce the triangle. When the three segments are laid out, cut part way through the cardboard with a sharp knife, along the lines where the material is to be folded. Fold with the scored side out. Before assembling the pieces permanently, test the bottom or lower segment to see that the lamp socket fits snugly in the openings cut for it.

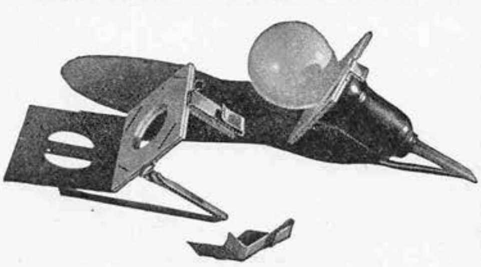
The application of color and tinsel is done best before the base is fastened to the triangle. The base can be finished in a variety of ways and with water or oil colors, brushing lacquer, quick-drying enamel, or with colored paper glued on.

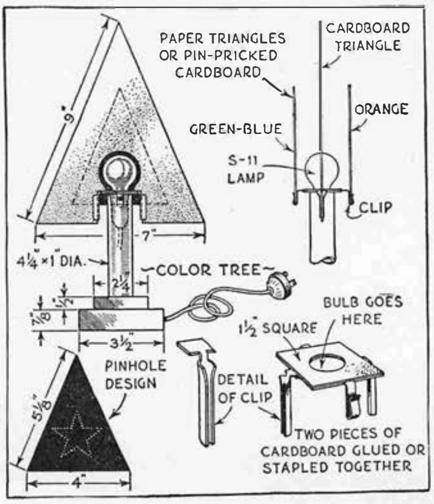
From a dealer in show-card artists' supplies you can purchase various kinds of tinsels or "flitter." These are metallic flake materials that reflect light. They are obtainable in various colors. For most purposes of Christmas decoration, the silvery tinsel, which is generally the least costly (about 35 cents for ¼ lb.) is satisfactory. The fine grade is preferable. Paint the front and back sloping surfaces



The small triangles are slipped into their clips at each side of the central triangle. *Below:* How the color tree is constructed

The illuminated color tree is beautiful to a degree no photo can show. *Below:* Clips of tin hold the cardboard sections in place





Home *for* Christmas

This masterpiece of lighting is a beautiful combination of effects anyone can duplicate

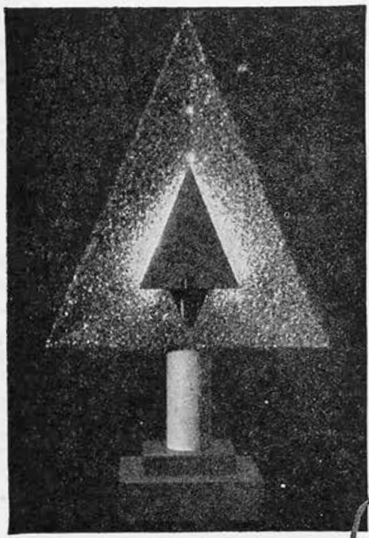
of the triangle with thin glue, such as white casein glue mixed with plenty of water, and sprinkle the tinsel liberally over the glue. When the adhesive has dried, remove excess tinsel by gently tapping the triangle edges with the fingers. These edges, incidentally, can be colored in any manner desired, as they do not reflect light from the bulb.

The "color tree" is simply a variation. Color one side of the central triangle red and the other green. The outer surface of one of the smaller triangles can be orange and that of the other silver. Tinsel of different colors is effective on the center triangle. In the smaller triangles, opposite the bulb, make a pinhole design—a star, reindeer, or other suitable form traced by punching holes through the cardboard with a needle.

The tinsel star is another decorative lighting novelty that is highly effective. It is particularly suitable for producing highlights in festoon decorations, and for window decoration. The star is made of heavy paper or thin cardboard, folded so that it is hollow on one side, and provided with a central hole that receives the base of an S-11 lamp. The hollow side of the star is covered with tinsel.

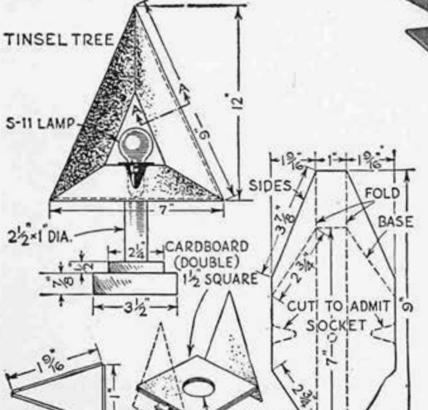
Even larger bulbs, such as the standard 25- or 40-watt size, can be employed to produce striking effects. For example, an interesting fixture for outside use can be made by mounting a socket in the center of a reflector having a matte surface, and equipping the bulb with a shield that is perforated with suitable designs. The reflector can be a 10-in. aluminum mixing bowl, the surface of which is given a matte finish by the application of a strong lye solution. A screw-ring porcelain socket is mounted in a hole in the center. The bulb is equipped with a shield cut from thin sheet metal (or even a cardboard medicine box of suitable size if the lamp is a small one). Tiny Christmas trees, flower petals, or other designs are cut in the shield and covered with one of the colored filter materials sold for use with store window lighting fixtures. The part of the shield covering the tip of the bulb and not entering into the reflected design can be fitted with a filter of a contrasting or harmonizing color.

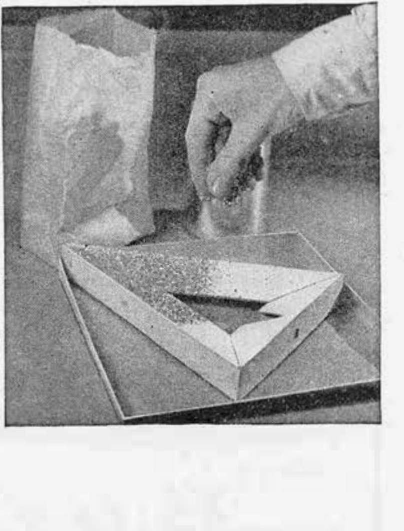
A variation of this principle can be applied to wall surfaces, such as the outside of a building. Mount a socket in the center of the area, insert a 60- or 100-watt bulb, and place around it a shield of fireproof material, suitably perforated and equipped with heatproof color material. A satisfactory shield can be made from an empty coffee can and lid. Mount the socket on the inside of the lid, and punch the design in the sides of the can with an old



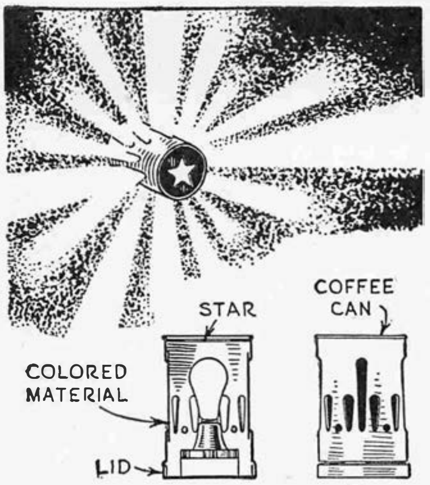
This glittering tree is suitable for a table, window, or mantel decoration. It is made almost entirely of cardboard and is lighted by a small lamp

Assembling the base and, below, inserting lamp in the center opening





How the ornament is made. Note that each leg of the triangle is itself triangular in cross section. *Right:* Sprinkling the tinsel



A decorative pattern of colored light can be played on a wall by using tin-can shields

knife or similar tool. Do not make the openings too wide. A star or other design can be punched in the can bottom. A combination of several of these units can be arranged.

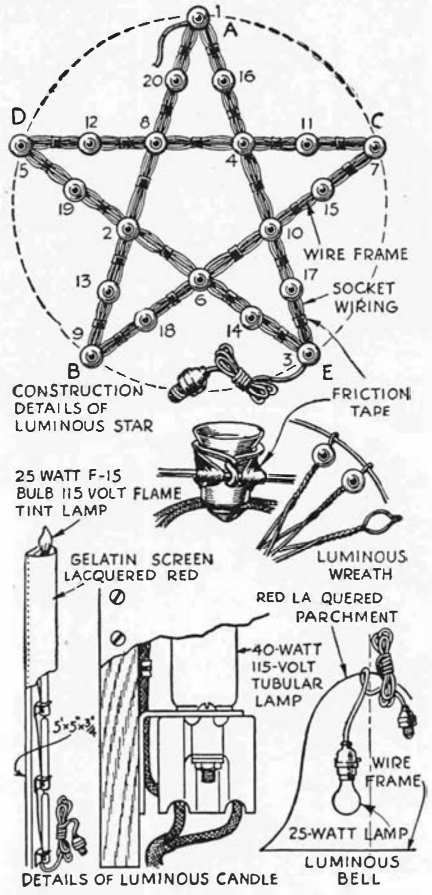
Among the available Christmas lighting equipment is a multiple-string bulb for tree lighting and for festoon decorations. It replaces the series string of eight lamps formerly used, and has the advantage that when one bulb burns out the remainder do not become extinguished. The multiple bulb is known as the C-7½ Mazda, multiple-burning lamp.

Several inexpensive outdoor lighting displays have been suggested for use with these sets. The method of making a star is to combine three multiple-type Christmas tree strings of seven lamps each. On an old table top or other surface into which nails can be driven, lay out a circle 28 in. in diameter. Divide the circle into five equal parts, and drive spikes. Draw lines connecting alternate points and drive spikes at the points marked 2, 4, 6, 8, 10 in the drawing of the completed star. A wire frame may be bent around these if desired, although for most purposes it will be found that the star holds its shape well enough without a frame. Fasten one of the end sockets of the first lamp string by tying the socket to spike 1 with a length of wire or string. Then continue to points 2, 3, 4, 5, etc., in succession, tying the sockets to the spikes. When the end of one lamp string is reached, connect the wires to the end of another string, and continue in accordance with the numbers as before. When the star form is complete, bind the wire strands between sockets with friction tape. The spikes may then be pulled out and the star removed.

Construction of a luminous wreath is a simple matter. Sockets for green S-11 or C-9½ lamps are arranged in a circle and supported by a wire hoop to which they are fastened with friction tape. The current-carrying wires can be brought together at the center and connected to a flexible electric cord.

Luminous candles mounted on either side of an entrance are particularly effective. The candle proper is formed by bending a strip of red screen-wire gelatin (flexible glass substitute) so that it assumes a half-round form. This material, of course, must be reasonably heat resistant and fireproof. The edges are tacked to a wood strip 5 or 6 in. wide and 4 or 5 ft. long. Along the center of this strip are mounted sign sockets to receive 40-watt tubular lamps or white-frosted 25-watt, T-6½ lamps. At the top of the candle structure is a medium screw socket for a 25-watt, F-15 flame-tint lamp.

Another effective ornament, for use at the ends of illuminated festoons, the peaks of gable ends, and the like, is a luminous bell. This is made by covering, with red-lacquered parchment or colored cloth, a wire bridge lamp shade frame that is shaped like a bell sliced in two. An ordinary 25-watt lamp is suspended inside.


A
B
C
D
E
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
WIRE FRAME
SOCKET WIRING
CONSTRUCTION DETAILS OF LUMINOUS STAR
FRICTION TAPE
25 WATT F-15 BULB 115 VOLT FLAME TINT LAMP
LUMINOUS WREATH
GELATIN SCREEN LACQUERED RED
RED LA QUERED PARCHMENT
40-WATT 115-VOLT TUBULAR LAMP
5"x5"x¾"
WIRE FRAME
25-WATT LAMP
LUMINOUS BELL
DETAILS OF LUMINOUS CANDLE

Suggestions for a luminous star, wreath, and bell, and method of constructing big candles

SPRAYS ALUMINUM PAINT ON CHRISTMAS TREE

SOMETHING new and outstanding in the way of Christmas-tree decoration can be had by using an ordinary insect gun to spray aluminum paint on the tree. A few minutes of vigorous pumping and the tree appears to be delicately fashioned of molten silver. No tinsel is needed to complete the decoration. Blue lights, if used alone, give a striking effect. A ten-cent can of paint is ample to cover a tree 6 ft. high.

BAMBOO SPLINTS KEEP SHOWER CURTAIN CLOSED

TO PREVENT the curtain of a shower from blowing in toward the spray and letting water run out on the floor, put bamboo or pine splints in the seams. One long splint for each side and a pair of short ones for the top and bottom are all that is needed. Use a pair of sharp scissors to cut a hole to slide each splint into the seam. The holes are then sewed up and the curtain is ready for use. There is no need to fear the wood will warp excessively if the curtain is waterproof.

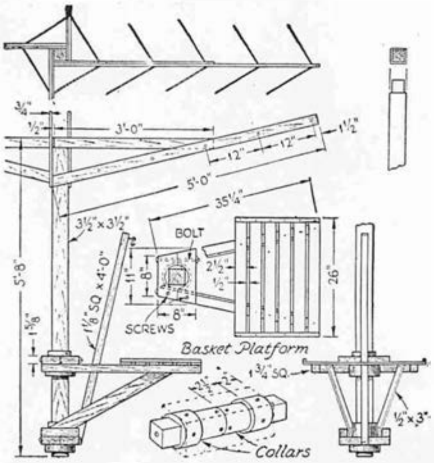
OUTDOOR CLOTHES DRIER HAS BASKET PLATFORM

As the lines become filled, the platform with the clothes basket is pushed around the post

THE task of hanging up clothes on a laundry clothes tree or outdoor drier can be made considerably easier by constructing a simple revolving table and bracket for the basket and clothespin bag. The table, with a slight push, turns around the clothes post as the line above becomes filled, and not much bending has to be done. This results in saving a good deal of time and energy.

To construct the collars upon which the platform revolves, take a block about 1 ft. long with the same cross section as the post to serve as a form. Center this piece in a lathe. Fasten a block of hardwood to each side, placing the screws near each end and countersinking them deeply. Then turn the whole to the shape shown in the small perspective sketch. Set two more countersunk screws in each side near the center, and cut the piece into two collars of equal size.

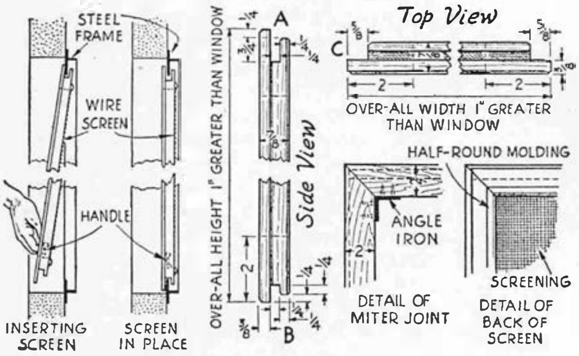
Remove the eight pieces from the square stock and fasten them to the clothes-tree post to form the two bearings upon which the table supports revolve. Blocks with a round hole of the same diameter are then made and bolted around these bearings.



How the drier, basket platform, and bearing collars are made. Note clothespin-bag hook

EASY WAY TO MAKE

Screens *for* Steel Casements



How the frames are constructed and, above, how the grooved top and bottom pieces are cut back

The top of the screen is inserted, then the bottom is pushed in and dropped into place

IN MANY cases, steel casement windows are not provided with adequate screens for the warm months of the year. An exception is the roll type of screen, which is ideal except for its cost. Because casement windows open outward, the ordinary full-length screen on the outside of the window cannot be used.

The inside screen illustrated is simple in construction, easily handled, and inexpensive. For the construction, a small circular saw fitted with a dado head will reduce the labor to a minimum, although the grooves can be worked out with special planes. Clear white pine ⅞ by 2 in. will be found easiest to work.

Determine the actual inside width and length of the steel frame with the window open. Now make the frame, with mitered joints at the corners, 1 in. greater in width and length than these dimensions, but do not fasten the parts. Mark these pieces to identify them later, especially the top and bottom, and also mark the front faces.

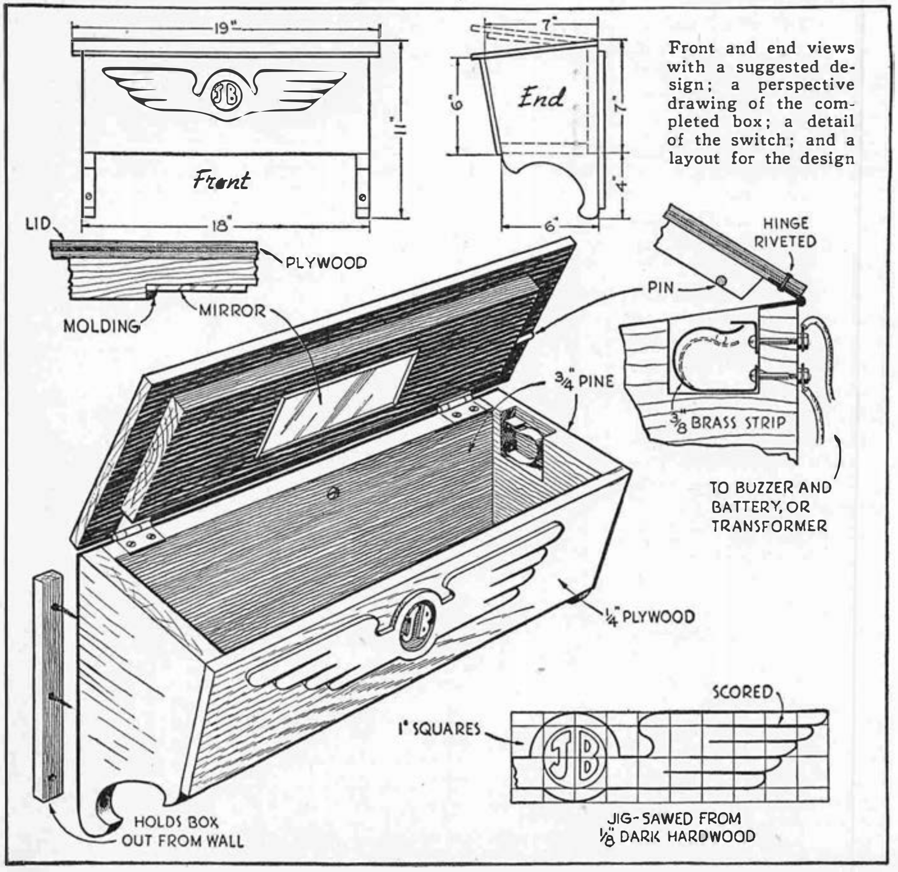
Now set up the dado head for a 1-in. cut and set the fence ⅜ in. away. Cut groove *A* in the toppiece with the front face against the fence. Lower the dado head to ½ in. and run groove *B* in the bottom.

Now reset the dado head for a ⅝-in. cut and rabbet the sidepieces as at *C*. Remove the dado and set up the circular saw for a ⅜-in. cut to remove ¼ in. from the back of the grooves in the top and bottom pieces. In running these through, be sure to rest the back of the piece on the saw table.

The frame is now assembled by using angle irons, or the miter joint can be glued with an inserted spline. The insect screening is put on in the usual way, and the screen is ready for finishing. Use a priming coat followed by two or more coats of enamel to match the woodwork.

To insert the screen in the window, hold the bottom in the right hand and use the left to guide the top of the screen until it fits around the steel lip of the frame. Push up with the right hand, then inward until the screen fits flat against the frame. Now let the screen down. A small handle fastened to the bottom rail as shown will aid in removing it.

MAIL BOX ANNOUNCES POSTMAN BY RINGING A BUZZER



Front and end views with a suggested design; a perspective drawing of the completed box; a detail of the switch; and a layout for the design

MANY useless trips to the mail box may be saved by installing a box like that illustrated, which rings a buzzer each time the lid is lifted. This not only announces the postman, but gives a warning should anyone attempt to meddle with the contents of the box. If desired, the box may also be placed breast high, out of the reach of mischievous small children, in which case a mirror is set in the lid to reflect the interior.

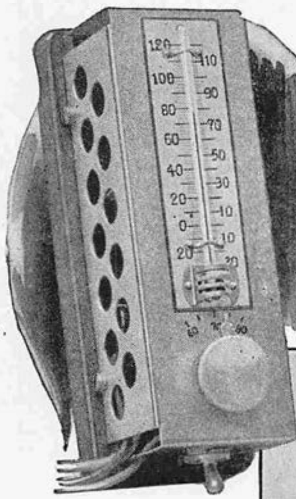
Pine and plywood are used in the construction, which is of the simplest type. The front may be embellished with a carved or scroll-sawed design, preferably in a hardwood darker than the background, if the box is to be finished in natural tones.

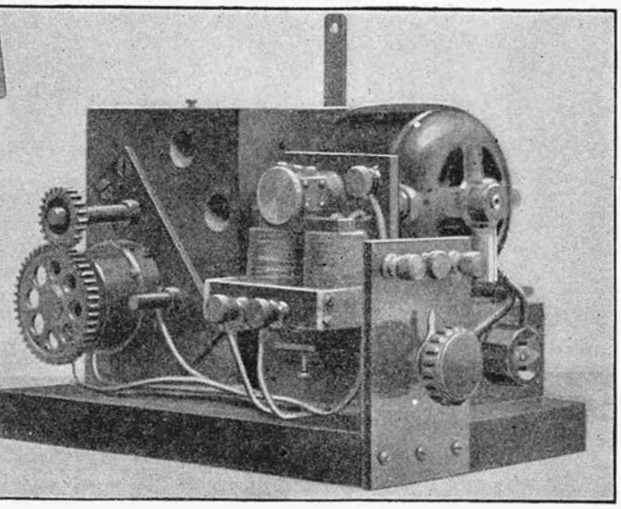
For the switch mechanism, a recess is made in one side and fitted with a strip of brass. This is kept from making an electrical contact by a pin, which depresses it when the lid is closed. When the switch is tested to your satisfaction, fasten wood or pasteboard over it to prevent long pieces of mail matter from throwing it out of adjustment. If the box is not shielded from the weather, be careful to protect the wiring adequately.

This type of box is intended to be attached to the side of the house or porch and is made unusually large to hold newspapers and magazines as well as letters. Of course, if your mail is light, the box need not be the full 19 in. wide, but can be shortened as desired.

Simple Heat-Control System

Saves Fuel and Insures Uniform Temperature





Above: **The complete thermostat unit. The knob is set to whatever temperature is desired; thereafter the heat-control system operates draft and damper automatically.** ***Right:*** **The motor unit**

NEARLY everyone who has seen or heard about automatic furnace heat-control systems wishes that his home had one. It not only provides a uniform temperature, but also effects a substantial saving in fuel costs. Heat-control equipment for a steam, hot-water, or hot-air heating system consists essentially of a room thermostat and a motor-driven device to operate the check and draft dampers on the furnace.

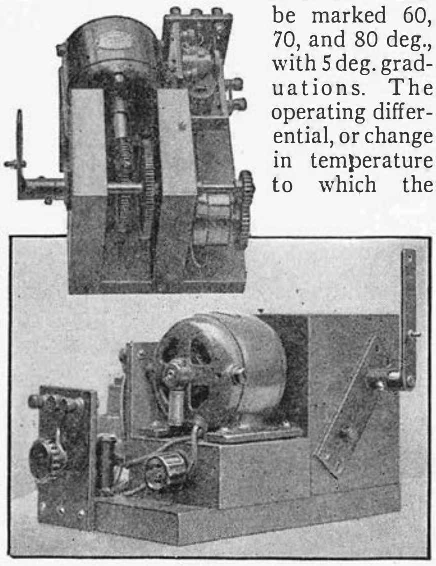
The thermostat is a bimetal strip shaped and mounted as shown. It is best to buy this thermostatic metal. You will need a strip from 8 to 10 in. long, ⅜ to ½ in. wide, and approximately .030 in. thick. The bimetal strip is soldered to a short piece of brass rod and then wrapped about it in a loose spiral for about half its length. At the end of the straight piece, solder a small silver or tungsten contact to each side. The short brass rod is next fastened to an insulating base of bakelite or similar material in such a manner as to enable it to turn, but not too freely. To the other end of the rod attach a long metal strip that will serve as the temperature adjusting lever. The fixed contacts also should have silver or tungsten tips. The holders for these may be made of ordinary binding posts. Mount them as indicated in one of the photographs. The gap between the fixed and movable contacts may be quite small (.004 to .006 in.) The electrical connections are the two fixed contacts, and the bimetal strip.

The insulating base should be fastened to a wood strip, which will serve as a mounting plate. A ventilated cover may be constructed of sheet metal. An inexpensive thermometer mounted on the face of this cover gives the finished thermostat a professional touch.

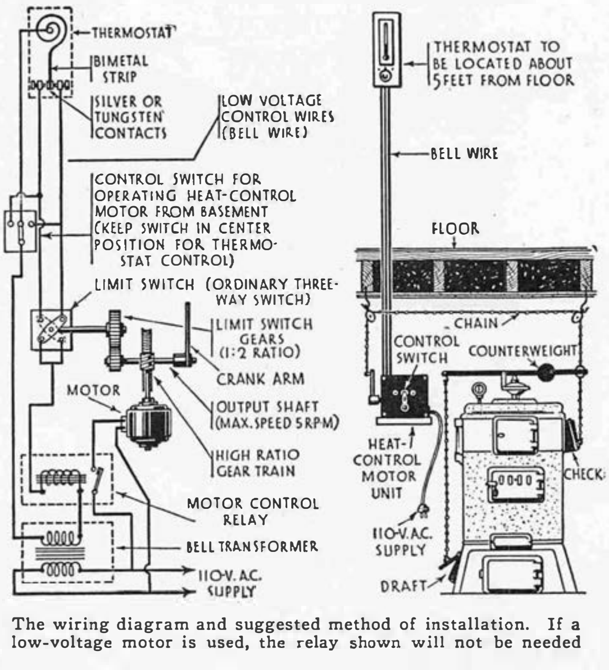
The method of indicating the temperature setting of the thermostat may be varied to suit the skill of the builder. The long adjusting lever may be brought through a slot in the bottom of the cover and fitted with a pointer to indicate the temperature setting on a calibrated scale. The method used on the original was to mount a knurled knob on the top of the cover and arrange it to turn a small radius arm fitted with a pin that moves in a slot cut in the adjusting lever. This scheme provides a relatively large circular motion of the knob for a small movement of the adjusting lever, which results in greater accuracy in calibrating and in making temperature settings.

After the thermostat is completed, it must be aged. This is accomplished by putting it in an oven at a temperature of approximately 250 deg. F. for a period of four hours, and then in a refrigerator for the same period. This aging process removes all stresses from the bimetal strip caused by shaping it to the spiral form.

The calibration is to determine the position of the adjusting lever for every desired room temperature. Measure the room temperature carefully. Move the adjusting lever so that the bimetal strip contact is midway between the two fixed contacts. Arrange a simple electrical circuit employing lights or buzzers to enable you to determine when the bimetal strip moves and makes contact with either of the stationary contacts. Raise the room temperature about 1 deg. This may be done by bringing a source of heat in the vicinity of the thermostat. The strip will move over and touch one of the stationary contacts. Now, lower the room temperature slightly. The bimetal strip will touch the other contact on a change of 1 deg. from the normal room temperature. Repeat this test for temperatures ranging from 60 to 80 deg. F., which is the average temperature range used in the majority of houses. Carefully note the adjusting lever position for each temperature taken, and calibrate a scale of these positions. It is suggested that the scale be marked 60, 70, and 80 deg., with 5 deg. graduations. The operating differential, or change in temperature to which the



Motor unit with gearing, crank arm, limit switch, relay, and fireman's control switch


THERMOSTAT
BIMETAL STRIP
SILVER OR TUNGSTEN CONTACTS
LOW VOLTAGE CONTROL WIRES (BELL WIRE)
CONTROL SWITCH FOR OPERATING HEAT-CONTROL MOTOR FROM BASEMENT (KEEP SWITCH IN CENTER POSITION FOR THERMOSTAT CONTROL)
LIMIT SWITCH (ORDINARY THREE-WAY SWITCH)
LIMIT SWITCH GEARS (1:2 RATIO)
CRANK ARM
MOTOR
OUTPUT SHAFT (MAX. SPEED 5 RPM)
HIGH RATIO GEAR TRAIN
MOTOR CONTROL RELAY
BELL TRANSFORMER
110-V. A.C. SUPPLY
THERMOSTAT TO BE LOCATED ABOUT 5 FEET FROM FLOOR
BELL WIRE
FLOOR
CHAIN
CONTROL SWITCH
COUNTERWEIGHT
HEAT-CONTROL MOTOR UNIT
CHECK
110-V. A.C. SUPPLY
DRAFT

The wiring diagram and suggested method of installation. If a low-voltage motor is used, the relay shown will not be needed thermostat will respond, may be varied by changing the contact gap between the fixed and movable contacts.

It is desirable, however, to have this gap as small as possible. A carefully constructed thermostat will operate on a plus or minus change of one degree. In other words, if the room temperature increases 1 deg. from the desired temperature, the thermostat will act in such a way as to cause the heating system to check itself; conversely, if the temperature drops 1 deg., it will cause the furnace draft to be opened.

The motor unit can take a variety of forms, although it is essentially a small fractional horsepower (ordinarily 1/50 H. P.) motor driving through a high-ratio gear train to an output shaft which makes but one-half revolution per movement. This half-revolution movement is accomplished by a simple limit switch.

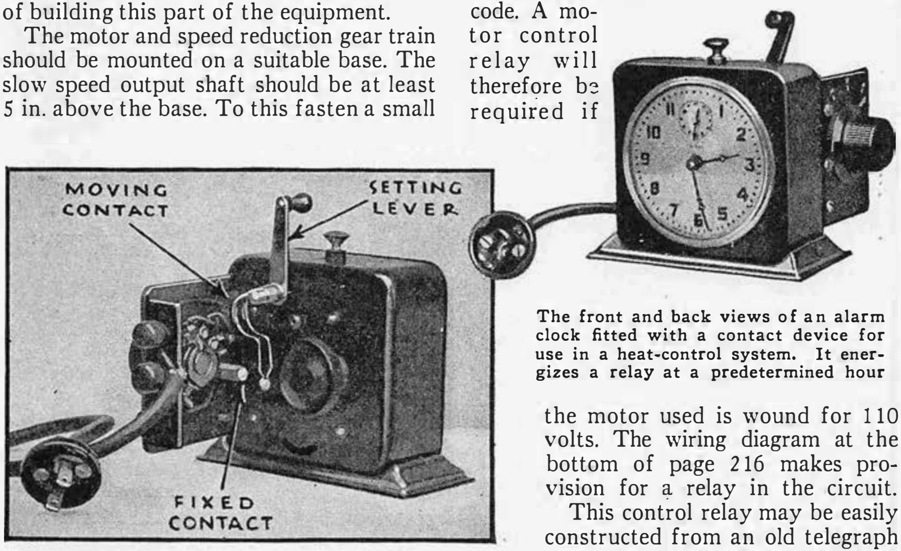
A motor-speed gear reduction assembly should be constructed of spur gears or worms and worm gears, so that the output shaft moves at a rate not exceeding 5 R. P. M. A motor with a self-contained speed reducer unit will save half the job of building this part of the equipment.

The motor and speed reduction gear train should be mounted on a suitable base. The slow speed output shaft should be at least 5 in. above the base. To this fasten a small crank arm with a radius of approximately 4 in. This crank arm is connected to a chain which operates the draft and check dampers.

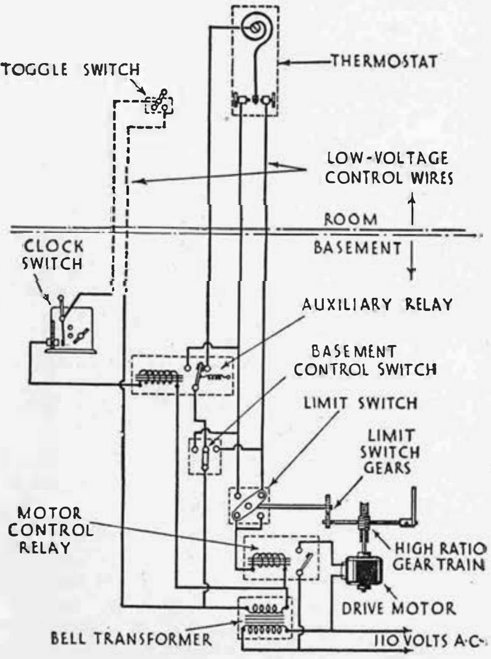
The limit switch is a standard three-way snap switch geared to the output shaft in the ratio of 1 to 2. This gearing allows the output shaft to make one-half revolution while the snap-switch shaft rotates one-quarter revolution, which is sufficient to snap it.

The details of constructing the motor unit with its speed reduction gearing will be left to the builder's ingenuity, since its form depends entirely on the parts available. The photographs show a motor unit from various angles and may be used as a general guide as to the form this apparatus should take. The motor may have either a 110-volt winding or a low-voltage winding. If a low-voltage motor is used, its power must be supplied from a transformer or dry cells.

It is recommended that the thermostat control circuit for this system be low voltage. This will enable the builder to run bell wire to the thermostat and not violate the house wiring code. A motor control relay will therefore be required if the motor used is wound for 110 volts. The wiring diagram at the bottom of page 216 makes provision for a relay in the circuit.



The front and back views of an alarm clock fitted with a contact device for use in a heat-control system. It energizes a relay at a predetermined hour

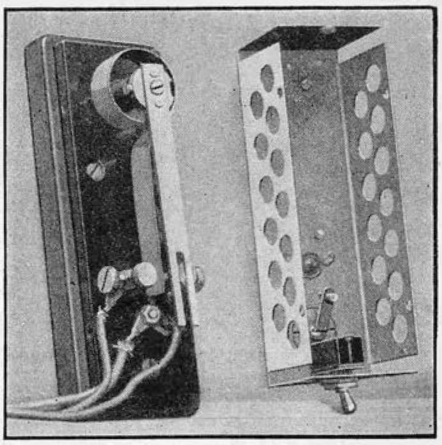


Wiring diagram of heat-control equipment with a clock switch to open draft early in the morning

This control relay may be easily constructed from an old telegraph relay, sounder, or bell-magnet coils. Simply mount a contact on the moving armature and another on an insulated support, so that the two meet when the magnet coils are energized. The control relay should be mounted on the motor assembly.

The equipment is now ready for wiring and installation. The thermostat should be located in the living room or hall about 5 ft. from the floor. Avoid placing it near radiators, chimneys, or pipes (exposed or concealed), on outside walls, near windows or behind doors.

Run the three bell wires down to the basement where the motor unit is mounted. Carry the chain from the arm of the heat-control motor unit over pulleys to the dampers. Adjust it so that it lifts the draft and check damper the exact distance found necessary. Set the counterweight of the ordinary furnace regulator so that the draft damper opens and the check closes by gravity when no steam pressure exists. On rising pressure, the bellows will automatically decrease the draft. Experiment with the draft slides in the furnace doors to obtain best combustion.



The thermostat. Note at right the radius arm that works in the adjusting lever slot

After the heat-control equipment has been installed and operated for a short time, the builder will undoubtedly wish to add a device that will automatically cause the furnace draft to be opened at a predetermined early hour in the morning. This will enable him to maintain a lower night temperature and still have the rooms warm when he arises in the morning. Such a device effects an additional fuel saving.

The alarm clock may be of the dollar type. Select one that has rigid wings on the winding keys. Wind up the alarm spring until it is almost fully wound. Now fasten to the alarm winding key a contact arm about 1½ in. long. Mount on an insulated block a fixed contact and fasten this to the clock case in a position where the moving contact attached to the winding key will strike it when the alarm is set off and the key unwinds. When this occurs and the contacts close, further unwinding of the alarm spring is prevented.

One photograph shows the back of an alarm clock fitted with such a contact arrangement. It is suggested that the builder fit the alarm winding key with a short lever that projects above the case, as shown. This will serve as an easy method to reset the moving contact and at the same time wind the alarm spring. Connect one wire to the moving contact and the other to the fixed contact mounted on the insulated block. These wires are the connections to the auxiliary relay coil circuit.

The relay may be constructed in a manner similar to the one used with the regular heat control system. The contact arrangement, however, should provide a normally closed circuit when the relay is not energized and make another circuit when the relay is energized. This is accomplished simply by adding to the relay base a contact post that will touch the moving contact on the relay armature when it is open. The spring on the armature, which serves to keep it open, will also provide the necessary contact pressure for this back contact—the normally closed one. The relay coil voltage should be the same as the one used with the original control system.

This auxiliary relay may be mounted in any convenient location, near or on the motor drive unit. The wiring diagram shows how all the connections should be arranged for both the contacts and the coil circuit.

HOW TO CUT A

New Entrance

In Any Frame House

PUTTING an additional entrance in a frame house or even through the basement wall is not an especially difficult job.

First build the complete frame, consisting of side and head jambs, outside trim, and drip molding at head, as indicated in the drawing. Nail securely and brace so that it can be handled as a unit.

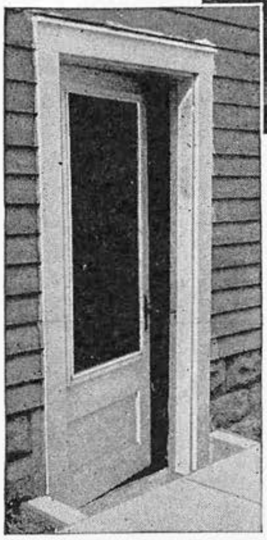
Then a rough opening in the wall should be cut in the desired location about ½ in. larger all around than the frame. Additional rough studding should be nailed in place at the side of this opening, and a header across the top.

If an entrance into the basement is being built, it may be necessary to cut the lower part of the opening through the foundation wall. If a spot can be selected where a basement window already provides this opening in the wall, much labor will be saved.

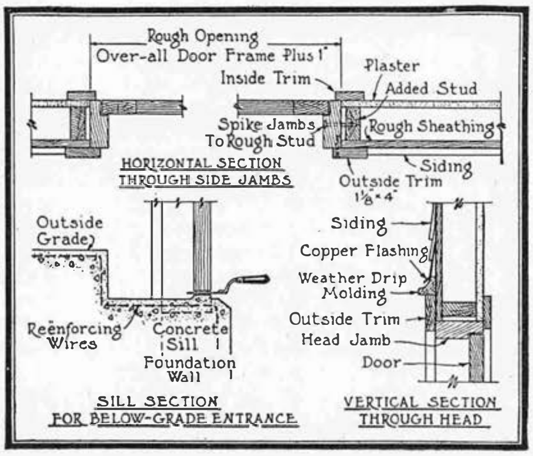
Temporarily wedge the frame in the opening and scribe a line around the trim on the siding. Remove the frame and nail a straight strip of wood along the scribed lines as a guide in sawing through the siding down to the sheathing.

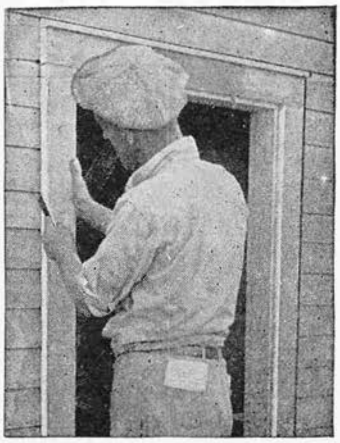
Paint the surfaces that will afterwards be inaccessible, and slide the frame back into the opening till the outside trim rests solidly against the sheathing, to which it should be nailed. The frame should also be nailed to the studding, using blocks between stud and frame near the nails so that the frame will not be forced out of line.

A straight strip of wood is nailed temporarily to the siding to guide the saw along lines marked from the frame itself as shown below



The completed entrance and, below, the working drawings



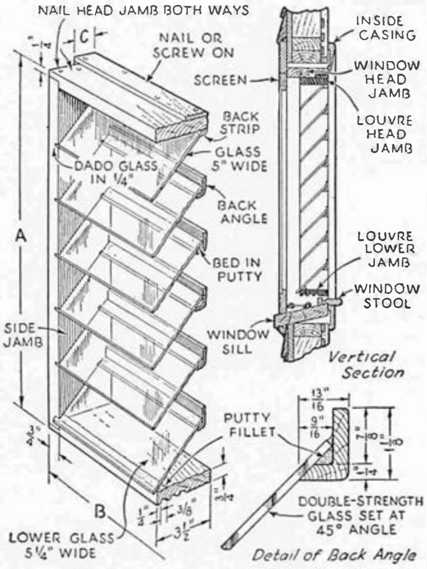


The frame is held in the roughly cut opening to scribe the outline

The opening between foundation walls and jamb should be filled with concrete of a stiff consistency, using temporary forms if necessary. Insert a copper flashing strip at the head of the doorframe. Fit and hang the door and, after patching up the plaster on the inside, nail the inside trim to the jambs.

The entrance illustrated is below grade, so the sill was made of cement. The side jambs were allowed to extend about 1 in. below the bottom of the door, and the cement sill was built up around them, level with the bottom edge of the door. Bottom clearance was insured by passing the trowel between the bottom edge of the door and the sill before the cement had set. If a wood sill is desired, it may be built into the frame at the start.

RAINPROOF VENTILATORS FOR ATTIC WINDOWS



How to make a window ventilator with glass louvres. Dimension *A* should be 1/16 in. less than distance between stool and head stop; *B* should be 1/16 in. less than distance between side stops; and *C* should be equal to the thickness of the casement window itself

WINDOWS in many attics are left open for ventilation during the entire summer. When a sudden storm blows up, however, someone must remember to close them or serious damage from rain may result.

This damage can be prevented and the windows can be forgotten for the summer if they are fitted with temporary frames containing glass louvres to keep out the rain. The louvres will allow almost as much air and light to pass as if the windows were wide open.

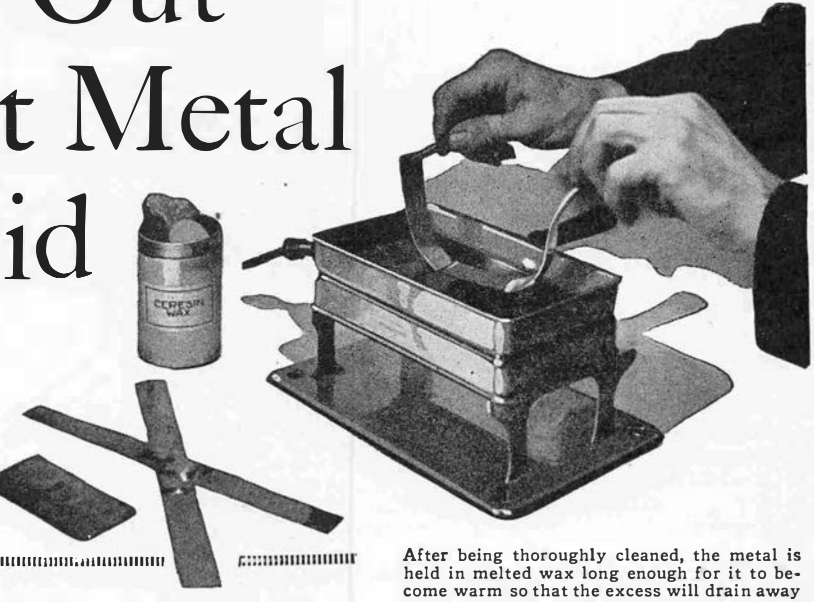
Ventilators of this type can easily be made to suit whatever windows are to be thus safeguarded. The accompanying drawings show one workmanlike way to make them for wooden casement windows. Such ventilators can also be used elsewhere in the house; for example, in a sleeping porch that faces on the street, where transluscent glass can be used instead of clear sheets.

When cutting the glass, make the lower sheet ¼ in. wider than the rest, for a projecting drip. In the construction illustrated, back strips of wood or metal are used to prevent water from blowing in. These strips do not add a great deal to the work and are an additional safeguard.

All wood and metal parts should be painted before assembling. For use with a casement window, the ventilator may be hinged to the window jamb in the same way as the casement, with a fastener to match. Merely by withdrawing the hinge pins, the casement sash may be removed and the ventilator substituted.

METAL WORK

Cutting Out Thin Sheet Metal *with* Acid



After being thoroughly cleaned, the metal is held in melted wax long enough for it to become warm so that the excess will drain away

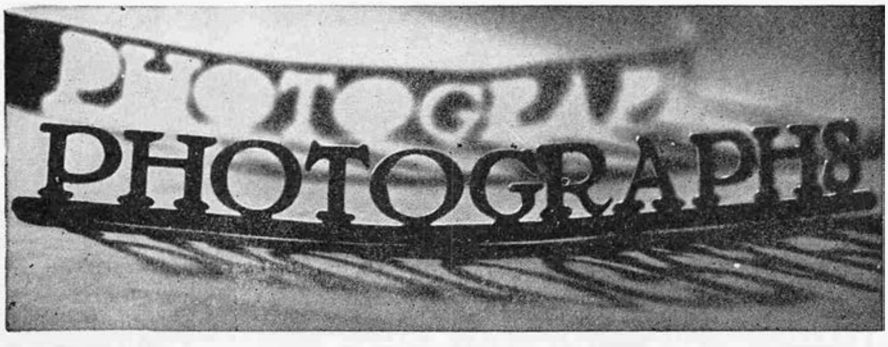
HERE'S a process every amateur mechanic should know about . . . It can be used for making ornaments, silhouettes, parts for models, stencils, and other projects . . . Engraving is done in the same way

DID you ever try to cut a delicate pattern from thin sheet metal without bending it? If not, perhaps you want to engrave figures or lettering on metal, such, for instance, as the numerals on a clock dial. Acid can be made to do both of these jobs without any disfiguration of the metal such as you would get if you tried to do the cutting or engraving by mechanical means.

Although not new, the process is often overlooked, yet every amateur craftsman should be familiar with it because it may be used for so many purposes. Suppose you wish to cut a metal sheet for the side of a miniature railway coach, with smooth, flat window sills. Acid will do it. Then you may want a neatly engraved name plate for a ship model, or a bookplate, or a fancy metal lamp shade. Acid will do the job again, and much more neatly than you could possibly hope to do it by the use of shears, files, or chisels.

Just try the method once to convince yourself. You'll find it handy for making metal ornaments or fine metal parts for models. Titles for stiff-backed books may be made this way, or special metal stencils for lettering, or even figures for framing. Silhouettes cut from polished copper and framed against a black background make striking and artistic wall decorations.

The procedure is simple, although certain precautions must be observed carefully. There are three major steps. First, you clean the metal and polish it as desired; then you coat it with a special acid-resistant wax. Second, you inscribe the design you want to cut out through the wax layer to the bare metal with a sharp scriber. Third, you immerse the metal in an acid bath especially prepared for the purpose, and soon the part or pattern is all neatly cut out, with no bent corners or ragged edges. All you have to do after that is to pull the unwanted parts away and clean the metal with gasoline. The individual steps will now be explained in detail.

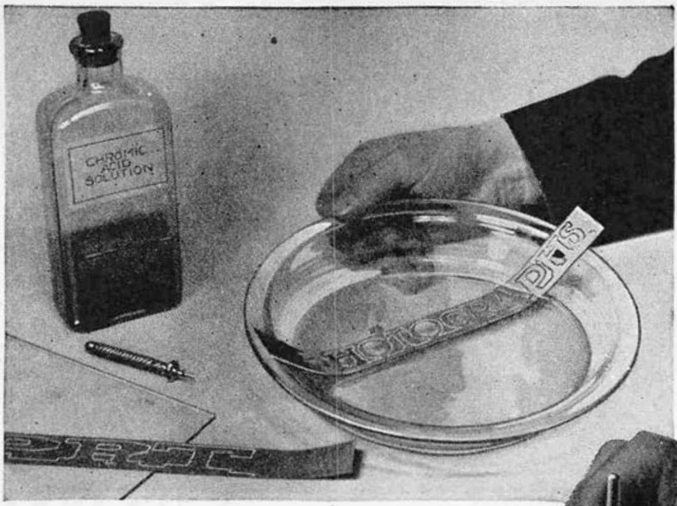


The metal parts, when etched, literally fall apart. The waste metal is shown in the background

Preparing the Metal. Success with the method depends upon care in each and every step. Whatever finish the metal is to be given should be completed before the etching or cutting operations, especially when the metal is very thin. It would obviously be difficult either to polish or grain a delicate pattern in thin sheet stock after it has been cut. Where figures are to be etched into the surface of a metal plate, the same thing applies. Attempts to polish it after the etching would result in rounding the edges of the fine details, consequently marring the appearance somewhat.

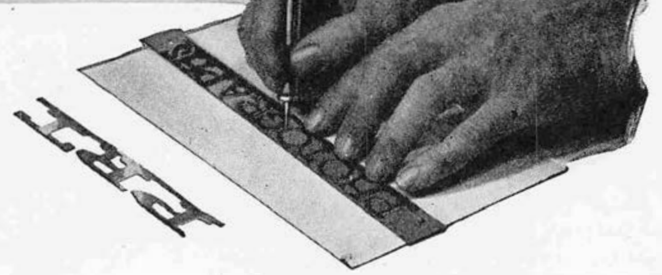
After the metal has been grained or polished, it should be cleaned thoroughly with benzine in order to remove any grease or particles of dirt. If stray greases are present, they may cause the acid-resistant wax to pull loose during etching. If dirt particles are present, the acid will attack them and subsequently reach the metal at those points and will thus destroy the pattern, or at least blemish it. It is a good plan to wipe the prepared metal with a small piece of chamois skin just before it is to be coated with the wax.

The Wax Coating. There have been any number of formulas published for making acid-resistant paints and preparations for use in etching metal. Some of them are all right, others are not. For the most part they are unnecessarily complicated. Asphaltum paint will work, but is not adapted to tracing since it is black and smears easily when scribing through it. After experiments with a great many preparations, one was found which is unusually convenient and satisfactory. It consists of either syncera or ceresin wax. These waxes may be obtained from most large drug stores and from practically any chemical supply house. Ordinary crayons can sometimes be used successfully. All you have to do is melt the wax, dip the metal in it and hold a moment so that the metal becomes warm and allows the excess wax to drain off. After the metal and wax have cooled, the wax layer will be quite hard and tough. The most useful feature of these waxes lies in their ability to protect the metal from most acids, and they do not fray or come loose around the edges during either etching or scribing.



After the design is inscribed through the wax, the metal is ready for the etching bath. A special solution is used to insure an even cutting action. It is slow acting but does a much better job than the baths often recommended for this purpose

Inscribing the Design Through the Wax. The scribing operation consists of cutting the desired design through the wax layer with a sharp point. Small pieces of tempered and ground drill rod set in old pen handles make convenient tools for doing this work. If only one pattern of a kind is to be cut from the metal, then the pattern may be laid out on paper and traced onto the wax with typewriter carbon paper. The design is afterward cut through the wax with the aid of straightedges and French curves, or even freehand.



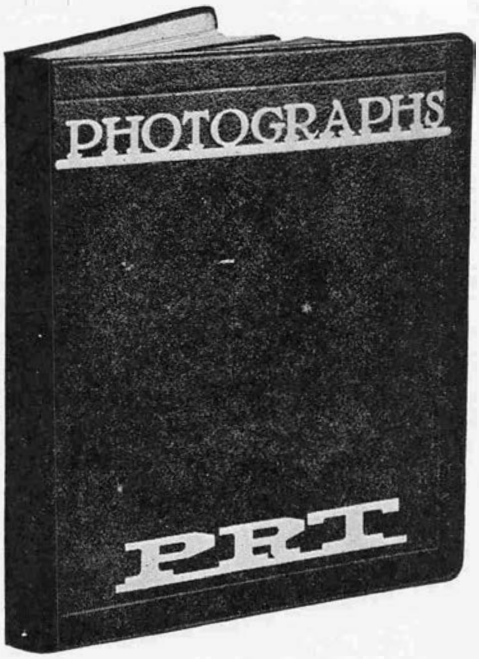
The second operation, illustrated at right, consists of cutting through the wax layer with a sharp scriber point. Celluloid templates may be used if many parts are needed

If a number of duplicate parts are to be made, it is best to make celluloid templates as guides for the scriber point. These templates may be made by tracing the design upon the surface of thin celluloid with a sharp point and breaking the celluloid apart along the lines. The design should then be smoothed up around the edges with fine sandpaper and files.

An easy method for holding the templates firmly on the waxed metal while doing the scriber work is simply to coat them on the back with rubber cement. When this is dry, you may press the template in place; and when you are ready to remove them, you may do so without fear of injuring the wax by pulling it loose along with the template.

If the metal being used is only two or three thousandths of an inch thick, it is best to place it on a sheet of glass during the scribing, as shown in one of the accompanying illustrations. The metal will bend if backed by a soft surface, and the tool will also have a tendency to dig in badly.

Etching the Metal. We come now to the last operation except cleaning, that of etching through or into the metal as the case may be. The experiments previously mentioned have shown conclusively that it is useless for the amateur to try to do neat work with any kind of nitric acid bath. This acid, although frequently mentioned for such purposes, is unsatisfactory for the reason that it produces gasses when reacting with the metal. These gasses appear in the form of small bubbles along the crevices in the wax, and soon the wax is loosened and the fine detail is ruined. Even though one or two patterns are successfully cut, they will not be smooth and even along the edges.



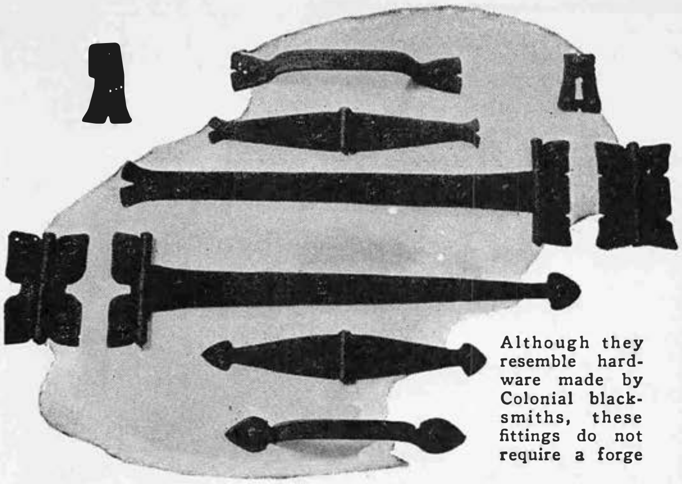
Metal lettering fastened to an album. The letters were attached with household cement and then coated with thin, clear lacquer

A special acid bath was developed which, although it is somewhat slow, works evenly and without the evolution of gasses. It consists of 3 oz.. of potassium bichromate dissolved in 32 oz. of water, and then 3 oz. of concentrated sulphuric acid are added. So far this solution is the ordinary photographer's chromic-acid tray cleaner. In this form it does not have the power to wet through exceptionally fine lines. This power is given it by the addition of a very little emulsifying oil, obtainable at most drug stores. If none can be obtained, then a little liquid soap will do. Rust inhibitor, used for auto radiators, works very well. The purpose of adding this is to lower the surface tension of the acid bath, or give it higher "wetting power," so to speak. There is another action taken by the soap, namely that of an inhibitor. That is, it slows the acid's action and at the same time causes it to act evenly all over the metal.

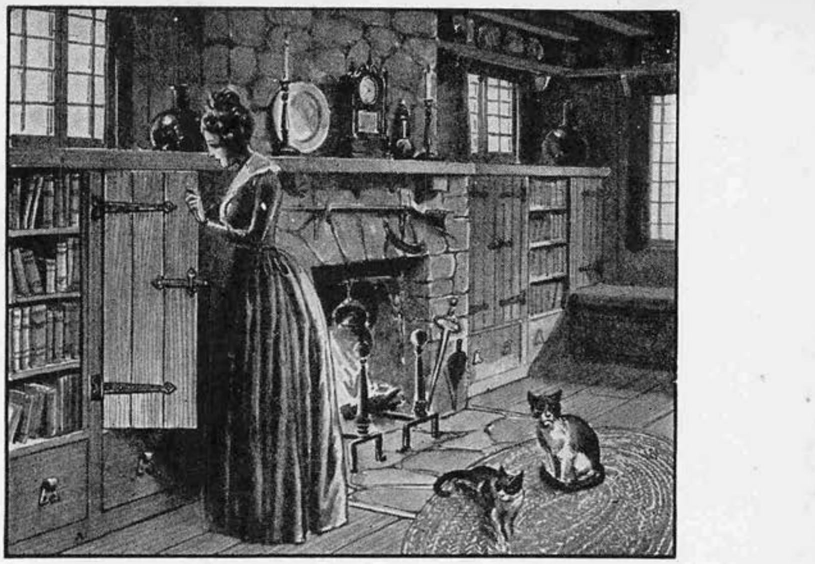
An acid bath of this type is suitable for use on brass, copper or steels other than the stainless variety. Copper is suggested for beginners. If aluminum is to be etched, this bath will work provided a little hydrochloric acid is added to the solution.

The speed of the bath, like all chemical reactions, depends on the temperature, About 80 deg. seems to give best results. When etching metals other than copper, the bath should be stirred frequently so as to remove by-products, which tend to coat the metal and slow down etching. If the metal has not been thoroughly cleaned before etching, ragged designs will result. A microscopic film of grease will resist the acid for some time.

At some time you may wish both to cut and engrave a design in thin metal. In order to do this, the outline is first scribed through the wax, the metal cut out as described before, and the engraving detail worked in with the scriber. The engraving then may be done by immersing the metal in the acid for a period of time equal to about half that required to cut clear through the metal.



Although they resemble hardware made by Colonial blacksmiths, these fittings do not require a forge



FINE-LOOKING

Hand-Wrought Hardware

MADE FROM CHEAP STEEL HINGES AND ORDINARY BAND IRON

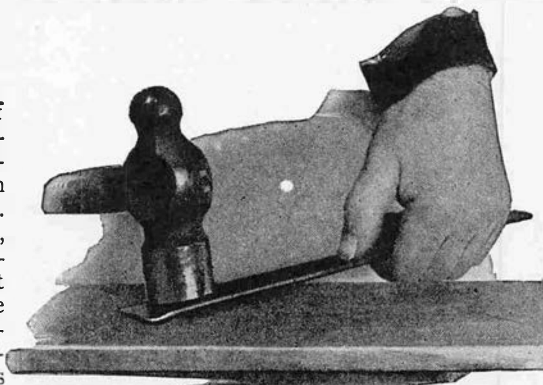
AFTER an excellent piece of furniture has been completed in the home workshop, it is often a problem to find suitable metal fittings for it. Common stock hinges and handles, useful as they are, may detract considerably from a carefully worked-out project, while hardware of suitable design and finish will add to its attractiveness. Such hardware, however, is relatively expensive. It is therefore an advantage to know how to convert mild steel hinges of the most inexpensive variety and ordinary band iron into fine-looking hardware suitable not only on furniture but on doors, closets, and cabinets.

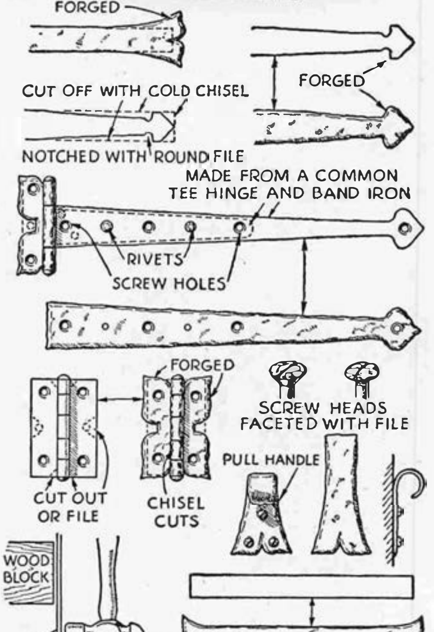
Simple and beautiful designs may easily be worked out in keeping with the period in which the house is planned, such as Early American or Dutch Colonial. The larger sizes of stock hinges may be modified for use on heavy doors in the same way. The finished work closely resembles real forgings; indeed, you actually do cold forging of a very simple character.

No forge is necessary for this work. Mild steel and band iron, which is really mild steel, can be worked cold because they will stand a lot of hammering before cracking. The metal may be annealed, if necessary, by heating it red hot and allowing it to cool in the air, but all the pieces illustrated were forged cold. The tools needed are generally found about the home shop—some sort of flat-faced anvil, the heavier the better; a good bench vise; a machinist's hammer; small and large cold chisels, very sharp; a few files, a hack saw, and a drill for drilling holes in mild steel.

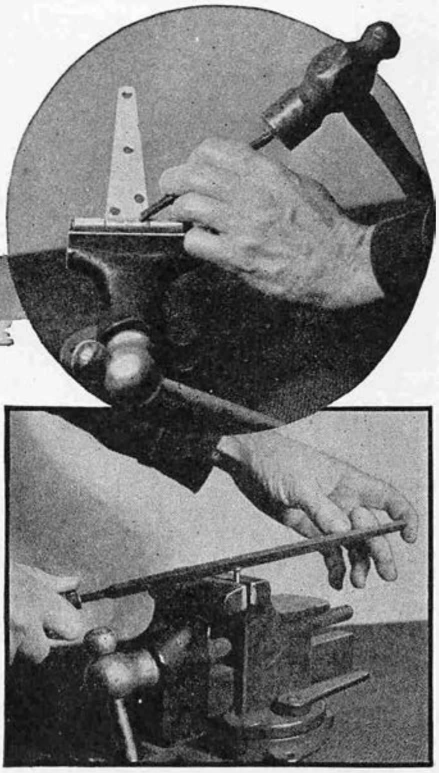
Plain 3-in. butt hinges (or any other size) may be altered until they resemble those shown to the extreme right and left of the group at the top of the page, and many other simple designs in outline may be obtained in the same way on this type of hinge or on the other pieces in that illustration.

The two long strap hinges of the old fishtail and leaf or spearhead design shown in the center of the group were made from 3-in. T-hinges with a length of cold-forged band iron riveted to the strap. When the hinge is finished and





Detail drawings and, above, forging fishtail on end of strap, which is cut to length later



Screw heads are filed to give a handmade look. *In circle:* Chiseling a hinge barrel mounted, the unusual form of construction is not noticed.

The strap hinge with both ends of the fishtail design shown in the upper center of the group was also made from a steel T-hinge by cutting off the extreme ends of the straps with the countersunk holes in them, and then hammering out the straps on the anvil to obtain the fishtail or fan-shaped end. The edge was worked from the topside with the hammer to obtain a low chamfered effect made up of hammer marks. The surface of the strap was also lightly hammer-marked. The flat, slightly rounded face of the hammer is used for this, not the ball peen, which gives a pock-marked effect rarely encountered in real wrought work. The notches were filed.

The strap hinge with the leaf-shaped ends (lower center) was made in the same way except that each side of the strap was cut away with a cold chisel or filed.

The barrels of all the hinges were chiseled over with a small, sharp cold chisel to obtain long facets resembling hammer marks (illustrated in circle). It is not practical to hammer a finished hinge barrel.

The strap or drawer handles shown at the top and bottom of the group were made of band iron slightly less than ⅛ in. in thickness, the ends being cold forged and the handle part formed in the vise. The key plate is a short length of band iron, forged, notched, and drilled. The pull handle shown at the upper left of the group was made in the same way, the curved-over part being hammered on the horn of an anvil or on a round steel bar held in the vise.

All these fixtures are screwed to the woodwork. As most commercial forms of hinges have countersunk holes in them, the newly drilled holes are countersunk also. Flathead screws are ordinarily used, but in this case the screws are altered to suit the pieces by filing the heads slightly round and by filing the facets on them as shown in one of the photographs. This gives the screws a much more attractive finish. Roundheaded screws may be treated in the same way, as may the heads of stove bolts.

These pieces are painted dead black as is usual with wrought iron. First, all dirt and oil are cleaned from them. A very durable finish may then be applied as follows: Paint the cleaned steel with aluminum bronze powder mixed with clear brushing lacquer to the consistency of thin cream. When this is thoroughly dry, brush on a coat of ordinary dead black paint, following this with a second coat when the first is dry. The paint may be purchased ready mixed or made by thinning drop black or ivory black with turpentine.

BLUE FOR METAL PARTS

An excellent blue that closely resembles the chemical blue applied to gun barrels can be made with ordinary liquid shellac and methylene blue. The latter is an aniline dye obtainable at drug stores. Add only enough to give the shellac a light blue color, testing on a piece of metal until it is dark enough. This finish may be used on any metal surface.

• • •

When tapping bakelite or other soft material, first tap a steel plate and clamp it in position; then drill through the hole in the plate and use the threads as a guide for the tap itself.

EASILY MADE
Tin-Foil DESIGNS

Gleam with Brilliant Metallic Colors

BRILLIANT, modern-looking wall pictures or decorations can be made from common tin foil and foil papers. A variety of such papers can be obtained from package wrappings. Other items required are a sheet of glass, enamel and lacquer, and a design to follow.

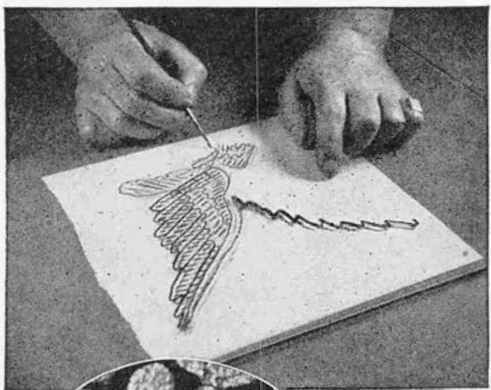
A parrot design was chosen for the picture illustrated. A sheet of glass of the size of the finished picture is placed over the design, which is traced with a fine brush and black enamel. Only the outline and important parts are marked. When this is finished, use some transparent lacquer in different colors to fill in the design, following the colors of the original as closely as possible. It is wise at this time to see that one particular color predominates and that it matches the color scheme of the room in which the picture is to be hung. Much contrast is permissible, however, as the coloring must be brilliant to be effective. If genuine transparent lacquer is not available, use clear lacquer to which dyes have been added.

Binding edges of a parrot design, which is painted on glass and backed with metal foil

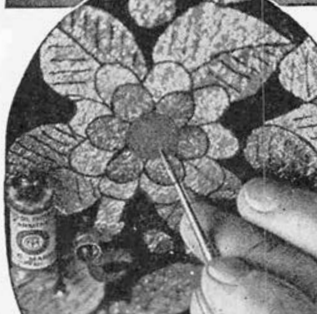
After coloring, the next operation is to fill in the background (in this case, around the parrot and foliage) with black enamel, applied in a thick coat. Then crinkle up a sheet of tin foil, open it again, and apply it with transparent cement wherever desired to form a background that can be seen through the lacquer colors when the picture is viewed from the right side—that is, from the unpainted side of the glass. This increases the brilliance of the colors.

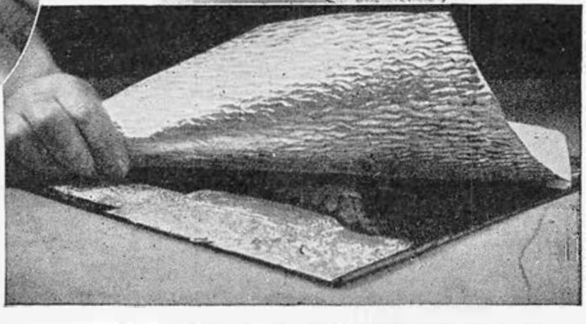
Obtain a sheet of gold-foil paper, such as jewelers use for wrapping their wares, and cement it down over the entire back of the design. This will give a background for any parts not covered with tin foil.

The picture is finished by fastening to a sheet of heavy cardboard.



Left: The outline is drawn or traced on glass with a brush and black enamel. ***Below:*** Cementing pieces of crinkled tin foil over parts of the painted design

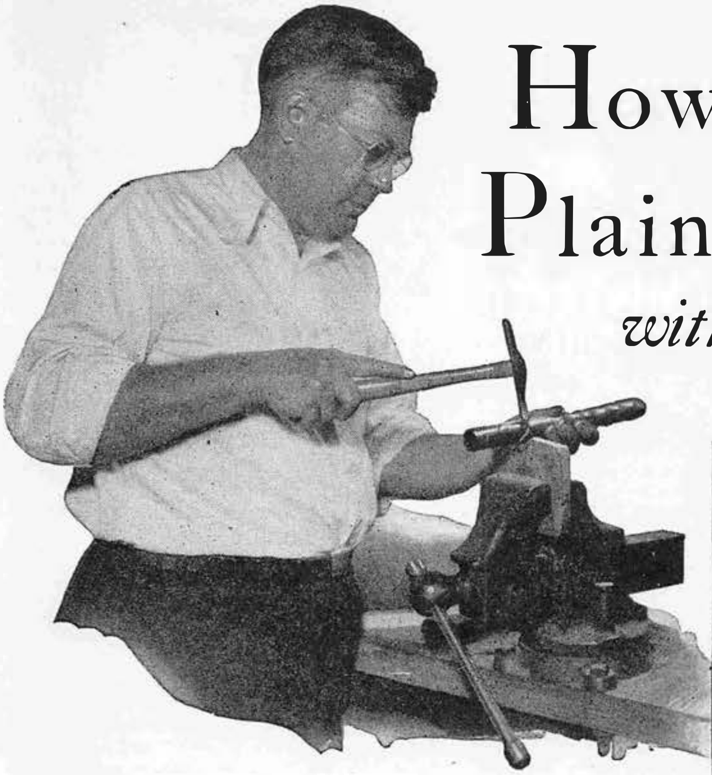




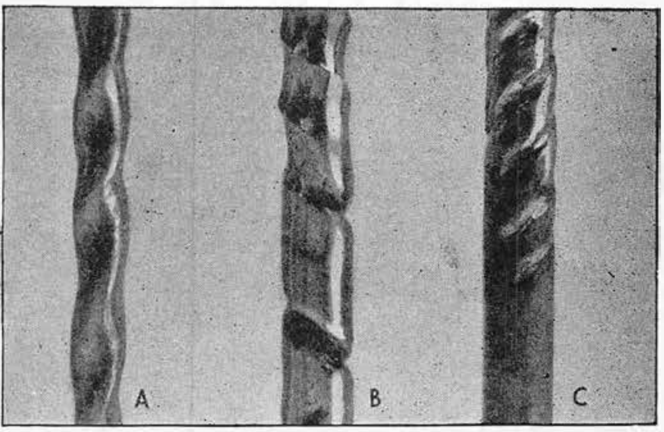
Above: The spaces inside the lines are tinted with transparent colored lacquer and backed with the foil, which shines brilliantly through the lacquer. ***Right:*** Placing the colored foil backing sheet

How to Ornament Plain Metal Tubing

with Graceful Spirals



The first stage in making the sample marked B at the right. The worker extends his forefinger along the hammer handle to give accurate control



HOMECRAFTERS frequently need a piece of ornamental tubing for some purpose, but as it cannot usually be found on the market, they content themselves with plain tubing. It is, however, comparatively easy to decorate ordinary brass or copper tubing with a variety of spiral or rope-twist effects.

So, without more ado, get the necessary plain tubing of the desired size. The thinner the tubing, the less work for yourself. Anneal it thoroughly by heating it red hot. Authorities differ as to whether it should be quenched in water or allowed to cool spontaneously. The professional metal worker says that the first leaves the metal softer, but the amateur will be able to detect no difference at all.

It is desirable to close one end of the tubing with a piece of brass or copper. This is silver soldered in place, and the edges are dressed down flush with the tubing. The fluting then can be carried clear out to the end. Soft solder may be used, but it will loosen under the hammering and the filling material will work out, so some allowance will have to be made for waste.

The tubing can be filled with rosin or lead if nothing else is available, but the former is too brittle and the latter is so hard it makes the work more difficult. What is known as "chaser's cement" is better; this is made up of varying proportions of rosin, plaster of Paris, tallow, and shoemaker's wax. A typical mixture is 5 lb. rosin, ½ lb. mutton tallow, 2 lb. plaster of Paris, and 1 lb. shoemaker's wax. The latter is frequently omitted. The rosin is melted, the tallow added, and the plaster, if used, is sprinkled in and thoroughly mixed by stirring. The cement must be melted each time it is to be used.

Fill the tubing with the melted compound up to the end. There is considerable shrinkage in cooling, and the resulting cavity or "pipe" can be filled later on if desired. The pitch is prevented from escaping too easily by hammering the metal over the open end.

The spiral is laid out on the work free-hand or by winding a strip of paper around the tubing and scribing a line along the edge. The second method, however, can be used only if a double spiral is desired. If a triple or quadruple spiral is wanted, the circumference of the tubing is divided into the desired number and an individual spiral drafted from each point.

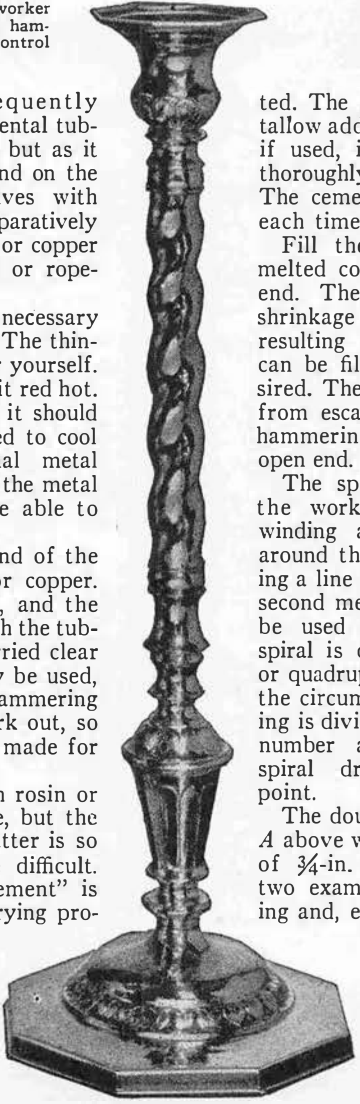
The double spiral shown at *A* above was made in a piece of ¾-in. tubing. The other two examples are 1-in. tubing and, even with this fairly large diameter, the three-spiral shown at *C* shows how much closer the spirals come together when more than two are used.

One illustration shows how the work is done on a lead block. If a sufficiently large block were used, the vise could be dispensed with. This photograph shows the initial stages by which the concave spiral in example *B* is arrived at. A raising hammer is used for scoring the tubing rather deeply; then the spaces between are hammered down with a ball-head form of planishing hammer. By reversing the work as you go along, the edges of the helixes can be sharpened up as cleanly as desired.

The initial stage in developing all three examples is to score along the spiral layout. It will be noted that *B* is produced by driving the metal down between the scored spirals, whereas in *A* and *C* the scored line serves as a starting point for rounding off the raised portions between to give each the effect of a strand in a piece of cordage. In order to do this, a raising hammer like that shown may be used, but one with a somewhat wider head and more on the order of a planishing hammer is better. In fact, a more or less flat, rectangular planishing hammer is the preferred tool; and the wider the face, the smoother the work will be.

The spirals can be raised or depressed almost as deeply as one desires, but for any unusual depth it will be advisable to melt out the pitch when the work has progressed about halfway, anneal the metal again, and then refill with pitch.

When the work has been finished, it is warmed, and the filling compound is run out into its container for future use. Melt it at a gentle temperature.

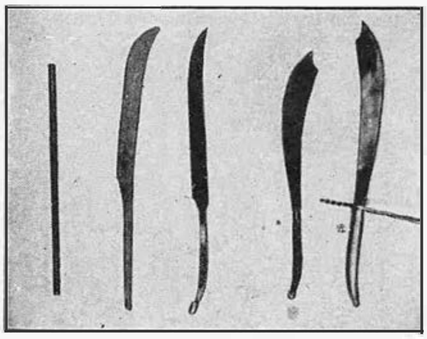


A candlestick with handmade spiral. The pitch or angle of the spiral and its depth may be modified as desired to suit the object

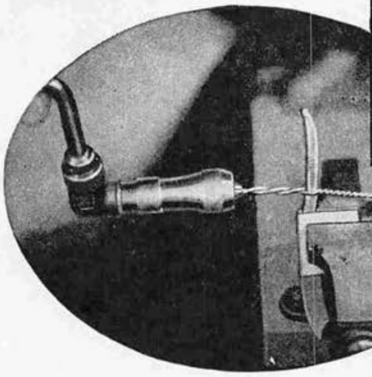
Artistic Paper Knives Cost Little to Make

ARTISTIC and useful letter openers may be made from small pieces of brass or copper and a few feet of wire. Those illustrated were formed from ⅜-in. brass rod, the handles wrapped with 16- or 18-gauge copper wire, and the guards shaped from thicker wire.

The rod is first hammered to the shape of the blade, and the handle is slightly flattened and formed to an oval section. The knife is finished by filing and then removing all file marks with emery cloth. A hole is drilled at one end of the handle to receive the end of the wrapping wire, and the entire handle closely wound.



How a brass rod is hammered and gradually transformed into a decorative letter opener



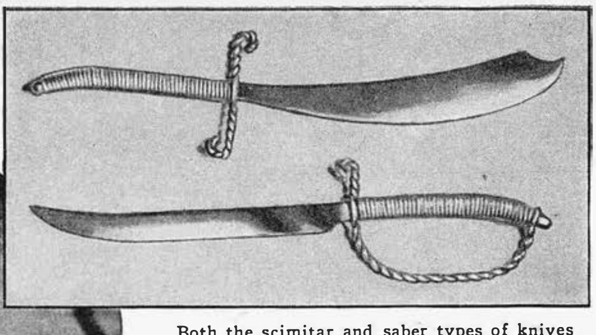
An auger-bit brace is used to twist the copper wire into a guard. Then the untwisted end is opened, fitted around the handle, and wrapped in a similar way

To make the twisted guard of the scimitar type, two pieces of 12- or 14-gauge copper wire 6 in. long are held in a vise and twisted with an auger-bit brace for half their length. The untwisted end is then opened, fitted around the handle, and twisted in the same manner. Care must be taken to have the wires placed evenly in the brace jaws and to keep a slight tension during the twisting.

The guard of the saber type is made from a piece of wire 12 in. long. Loop the wire around the butt of the handle and place the ends as far into the jaws of the brace as possible. Twist tightly, open the untwisted end, fit it around the forward end of the handle, and complete the twist. Then trim the ends to length and finish.

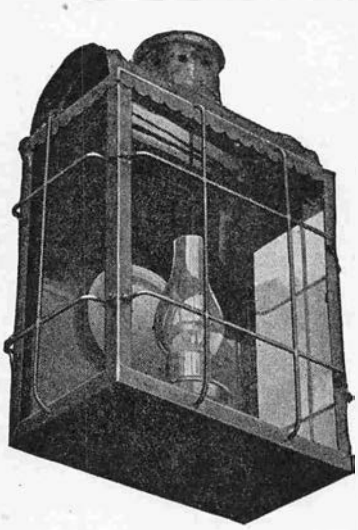
Any looseness in the guard at the point of contact with the handle may be easily overcome by sweating the joint with solder, and it is wise also to solder lightly the end of the twist to prevent the wires from separating when bending the small curl at the ends. Final polishing may be done with powdered pumice, steel wool, metal polish, or a buffing wheel if it is available.

A word of caution may be necessary: hammering or working brass or copper hardens the metal and if carried too far, may cause it to split or crumble. After the metal has been hammered until hard, it may be softened again by annealing. To anneal, heat the metal until uniformly red, and cool by plunging in water or allowing to cool normally. Copper may be forged red hot, just as iron or steel, but brass, being an alloy, may crumble if worked hot.



Both the scimitar and saber types of knives are useful novelties for your desk or table

Decorative Porch Lamp of Marine Design Is Made of Brass

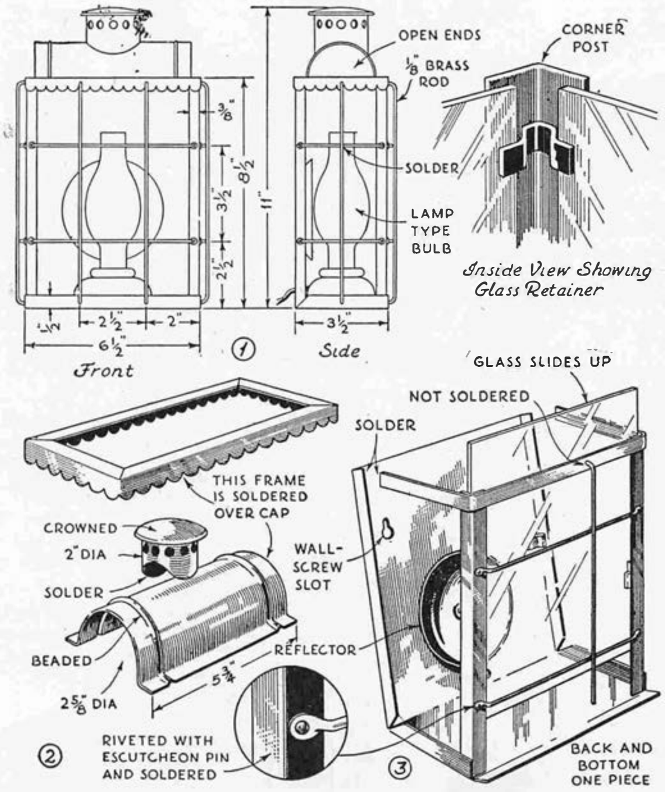


THIS attractive marine-type lamp, made of sheet brass and light brass rod, requires little experience in sheet-metal work. With a kerosene lamp type of electric bulb, if one can be obtained, and a suitable reflector, it is particularly effective and gives ample light.

Note that the bottom and back are made of one piece of sheet brass cut as shown in Fig. 3. The edges are bent over and soldered. The front corner pieces are simply ¾-in. strips of brass bent down the middle at right angles to form angle posts. A flat strip is soldered around the top, making the complete frame. Before the front corner pieces are set in, however, small retaining strips should be soldered inside.

The brass wire rods, which are about ⅛ in. in diameter, are flattened, drilled at the ends, riveted with cut-off brass escutcheon pins, and soldered. These are for the horizontal bars in front of the glass. The vertical bars are soldered only to the horizontal ones.

For the cap, make a rectangular frame as illustrated in Fig. 2. This fits over, and is soldered to, a semicylindrical piece with open ends. A small turret is soldered on top of this. This top unit should be made a neat fit over the lamp frame, and, of course, it must be removable so the glass panes can be renewed in case of breakage.



Front and side views and sketches showing method of construction. A lamp of this type is particularly effective if hung against a white wall

HOMEMADE TOOL

Shapes Metal Tubing

IN COUNTLESS DECORATIVE FORMS

SUPPOSE you wish to make a ferrule for a lamp standard, or anything of that sort. First prepare a tool from a piece of ½-in. drill rod, 8 or 10 in. long. About ½ in. from the end, cut a notch slightly more than halfway through the steel. The bottom of the notch is rounded out smoothly, the back is smoothed off to make an easy curve, and the end is rounded off more or less spherically.

Clamp this tool solidly in the vise as shown in the upper illustration and slip a short length of annealed brass or copper tubing, say 2 or 3 in. long, over it. A planishing hammer and a raising hammer are desirable although not essential for your initial experiments.

With the tubing in place, take the sharp end of the raising hammer, or riveting hammer and start hammering the metal down into the notch of the tool, turning the work as you hammer. This will result in a constriction or neck, which can be driven down almost as deeply as desired, provided room is still left for removing the tool.

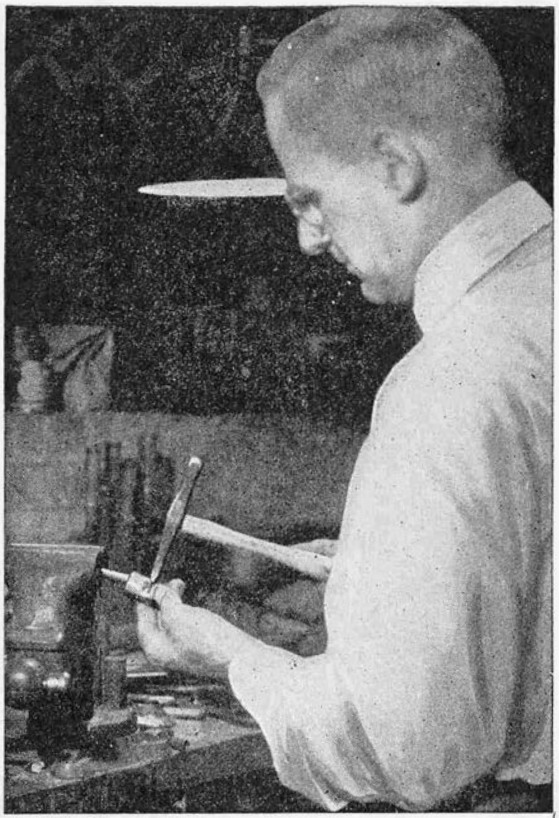
A simple socket, frequently needed for a variety of purposes, is made by hammering the end of the tubing up against the backward slope of the notch. Tilt the work and move it back and forth and up and down as the flange is expanded, as shown in the diagram marked *A*. The direction for hammering is indicated by the arrows.

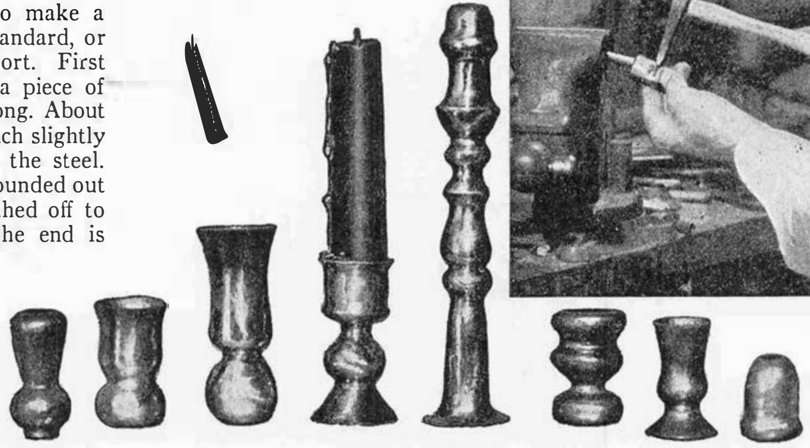
If a ball or bead is desired at any point along the work, another neck is driven in as at *B*, and the metal between is then worked out on the end of the tool, the tubing being reversed as required. At *C* is shown a variation used for forming a ball or oval over the end of the tool, and *D* shows another application.

When it is desired to reduce the diameter of the tubing in order to emphasize a ball or bead, the parts beyond the necks are hammered down, as at *E*, on the cylindrical part of the tool, the work being reversed as required.

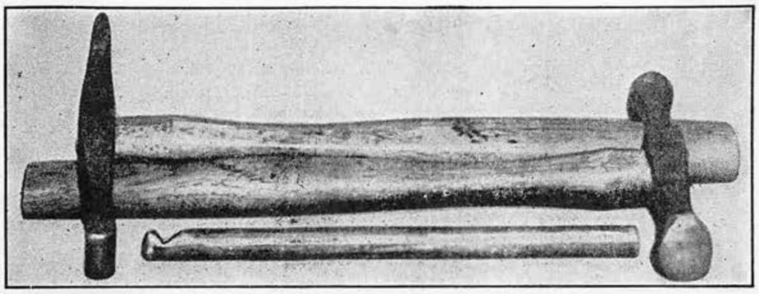
The method closely resembles turning in wood and is really quite simple, but it does require a certain amount of practice. The most important point is to drive the neck in at right angles to the axis of the work in order to keep it from being lopsided, although it is, of course, entirely possible to straighten out a crooked neck. If the neck is to be driven in deeply, drive it in for only part of the way, then anneal and drive it in deeper, repeating the operation until the proper depth has been attained. Frequent annealing takes time, but will save spoiled work.

The largest individual piece illustrated in the photographic group is only 3 in. long; and short lengths are to be preferred since it gives the worker greater opportunity to manipulate the metal over the end of the tool. The tall section at the right of the candle socket is not a single piece of work, but is built up from three separate pieces, and this method should be followed in the development of similar projects. It is possible to join any number of such parts.

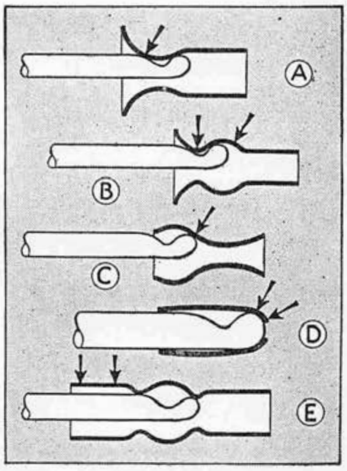




The tool is gripped in a vise and used as an anvil. At left are a variety of sockets and ferrules. The tall example is in three parts

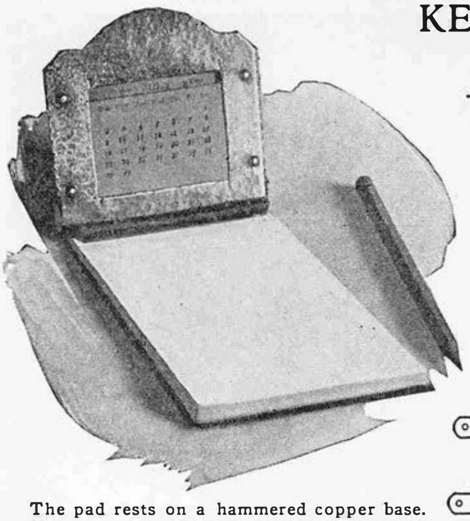


Only two ordinary metal-working hammers and a short drill rod notched near one end are required for making many artistic projects of copper and brass

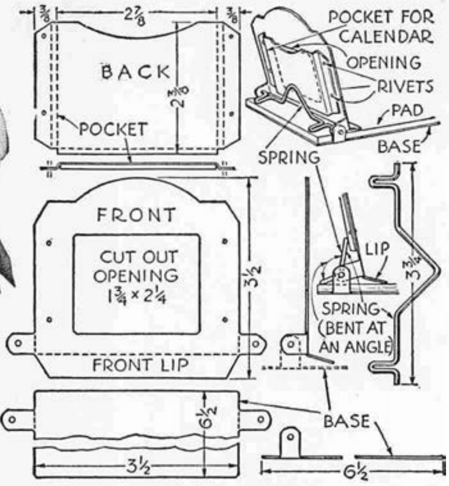


Diagrams showing how metal is formed by hammering the tubing against the notch. At left is a lamp, the central ferrule of which was made in two parts and soldered

KEEPING PAD AND CALENDAR TOGETHER



The pad rests on a hammered copper base. To remove or replace it, the calendar pocket is pressed backward against the bent wire



To MAKE the combination memo pad and calendar illustrated above, first lay out and cut the base from 18-gage soft sheet copper. It is 3½ by 6½ in. with two lugs or extensions ⅜ in. wide and ½ in. long. The total width of the blank must therefore be 4½ in. Hammer one side, drill holes in the lugs, and bend up. The face is cut from a piece of the same material 3½ by 4½ in. The side lugs are each ⅜ by ½ in., so the finished width is actually 3½ in. The front lip is ½ in. wide, Cut out the center opening with a chisel or a jeweler's saw. Hammer, drill holes, and bend to shape.

For the pocket 24-gage copper is used. This is not hammered. The spring is made from 6½-in. length of 3/32-in. hard copper wire.

All riveting is done with brass escutcheon pins. The calendar is attached to the base with the spring, which also acts as a grip for a memo pad. Spring the two ends through the lugs on the face, then pass them on through the lugs on the base. The V in the center should rest against the back of calendar.

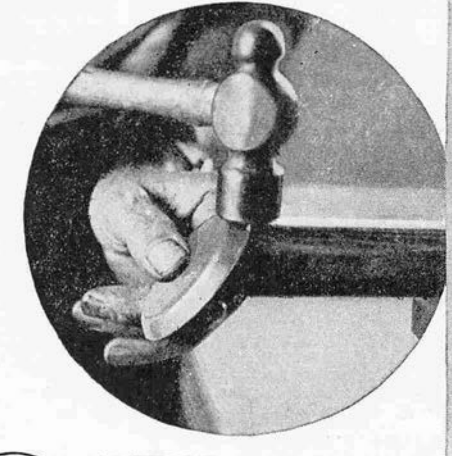
Dissolve a small piece of liver of sulphur in a quart of water. After washing the pieces thoroughly, immerse them in this until they take on a brown color; then wash, dry, polish, and protect the surface with lacquer.

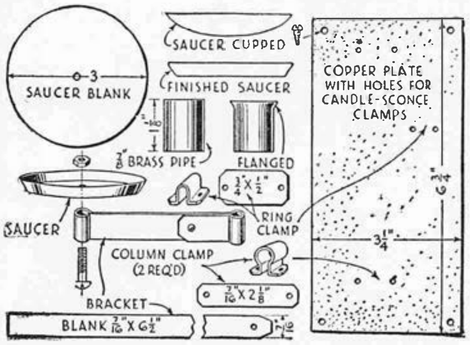
MODERNISTIC HOLDER FOR A CANDLE

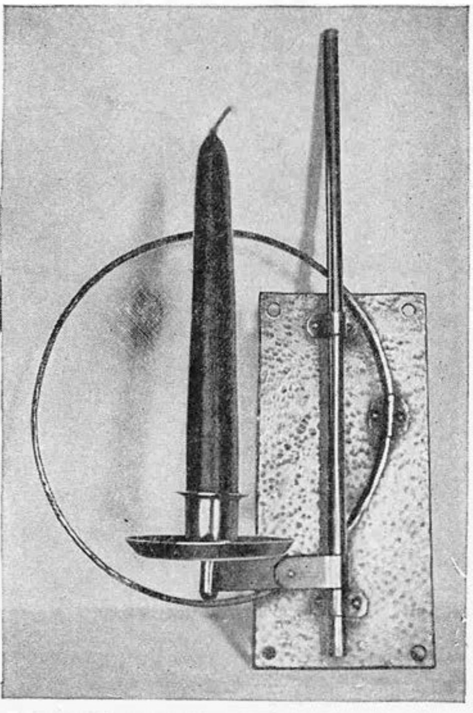
BECAUSE if its unusual modern design, this adjustable candle holder should appeal to amateur metal workers. The ring is a 22-in. length of 3/16-in. copper wire, which is hammered flat and soldered or riveted at the joint. The plate is made of 16-gage sheet copper. It is given a hammered finish, and holes are drilled as shown. The clamps are also of 16-gage copper.

The column is 5/16-in. outside diameter brass tubing 12 in. long. The bracket is of 18-gage sheet brass, shaped as shown. The saucer also is of 18-gage brass. It is cupped by hammering on the inside and expanding to a depth of about ⅜ in. Then place a round hardwood stick in the vise and shape the saucer over this. Drill a ¼-in. hole through the center.

The candle cup is made from a 1⅛-in. length of ⅞-in. brass tubing with one end flanged. Solder the cup into the saucer, then attach the completed cup and saucer to the bracket with a ¼-in. round-headed brass machine screw. Slip the bracket onto the brass column and assemble the entire candle holder. Polish the piece all over and lacquer.

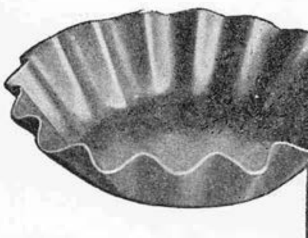




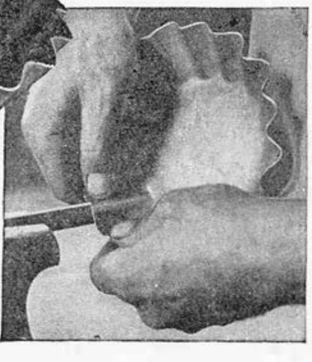


The striking arrangement of straight and circular lines and the contrast between brass and copper make this candle holder especially appropriate to use in any room furnished in modern style. The saucer is hammered over a round hardwood stick held in the vise as in the circle

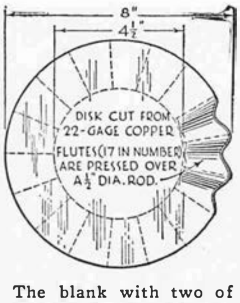
SIMPLY MADE COPPER BONBON DISH HAS FLUTED RIM



If the flutes are evenly spaced and well rounded, this simple little bonbon dish is an attractive piece



You can form the flutes by bending them over a rod or piece of pipe ½ in. in diameter with your fingers


8"
4½"
DISK CUT FROM 22-GAGE COPPER
FLUTES (17 IN NUMBER) ARE PRESSED OVER A ½" DIA. ROD.

The blank with two of the flutes bent. The spacing is done by eye

THIS fluted copper bonbon dish is one of the simplest pieces that can be made by hand, and yet is useful and attractive. Cut a disk 8 in. in diameter from a sheet of shiny new 22-gage soft sheet copper, and draw a 4½-in. circle in the center. The flutes are formed by placing a rod or piece of pipe ½ in. in diameter in the vise and pressing the edge of the disk down over it. Bend in to the line of the 4½-in. circle, as shown. Try to get the flutes as evenly spaced as possible. working from both sides. When completed, polish all over. Lacquering should be omitted.

HAMMERED COPPER
Bud-Vase Holder

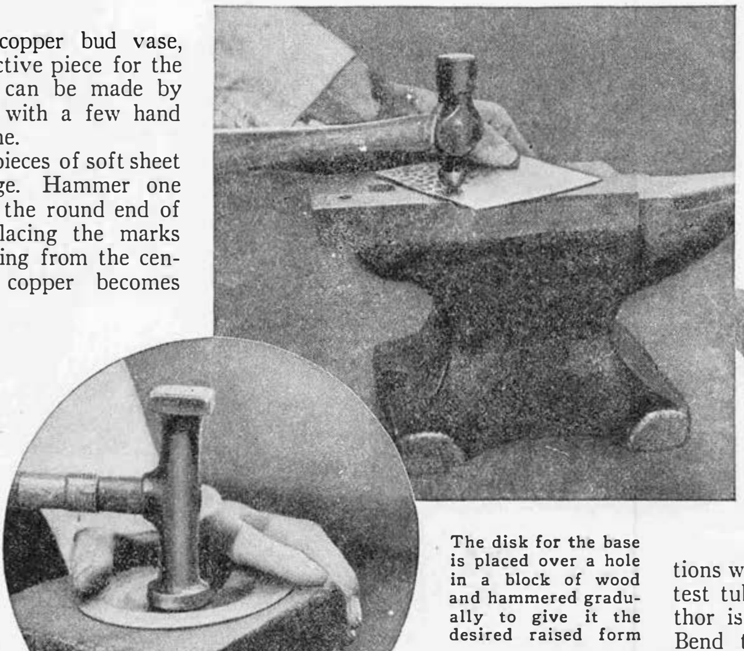
THIS hammered copper bud vase, which is an attractive piece for the table or mantel, can be made by the amateur craftsman with a few hand tools in an evening's time.

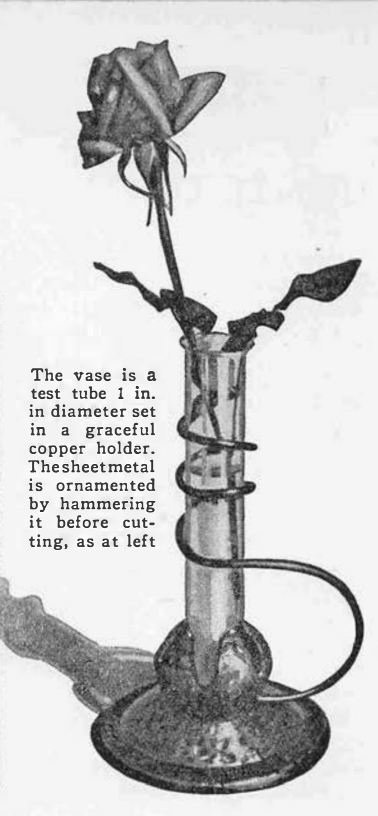
Cut two 4-in. square pieces of soft sheet copper, 20 or 22 gauge. Hammer one side of each piece with the round end of a ball-peen hammer, placing the marks close together and working from the center outward. If the copper becomes springy and tends to curl up, it may be softened by holding it over a flame until it turns black and then plunging it quickly into cold water.

Find the center of each piece and scribe a circle 4 in. in diameter. Scribe two additional circles on one of the pieces, 3 and 3⅝ in., as shown in Fig. 1 of the drawings. Cut each piece around the outside circle.

Place one of the pieces, which is to serve as the base, over a rounded hole in a block of wood, the hole being about 3½ in. in diameter. The hammered side should be turned down over the hole. Raise the center by beginning to hammer at the 3-in. circle and gradually working toward the center. This operation will have to be repeated several times until the desired shape and depth are obtained. Do not attempt to do this in one operation because the hammer may break through the copper. In order to keep the copper soft and pliable, it will be necessary to soften it occasionally as described before. The hammer shown is the type commonly used for removing dents from automobile fenders, but the flat face of an ordinary ball-peen hammer may be used if the edge is rounded slightly to avoid cutting the metal.

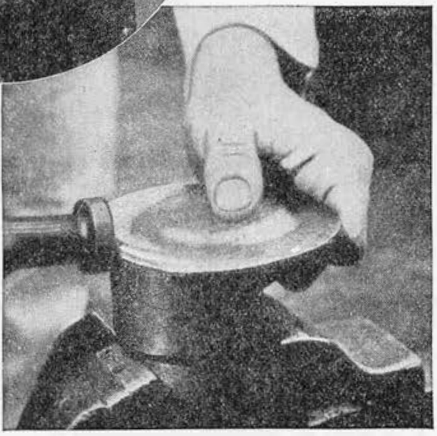
Turn the edge of the base as shown by placing it over a circular piece of steel or hard wood. Figure 2 gives the shape of the completed base.



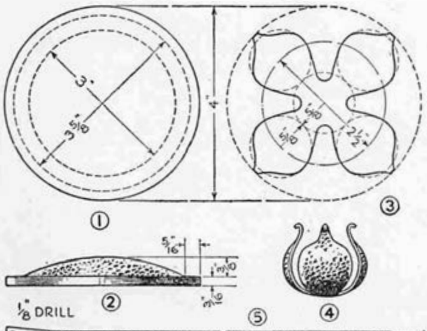


The vase is a test tube 1 in. in diameter set in a graceful copper holder. The sheet metal is ornamented by hammering it before cutting, as at left

The disk for the base is placed over a hole in a block of wood and hammered gradually to give it the desired raised form



To turn the edge of the base, the metal is held over a circular block of wood or steel



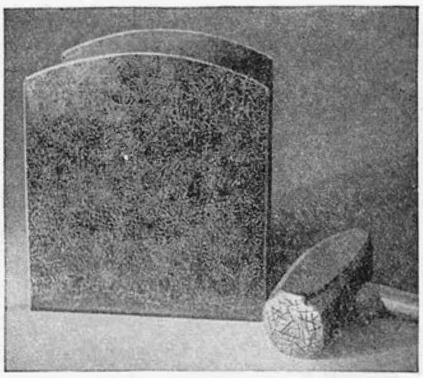
How to lay out the stock for both pieces of the base, and sketches of the finished parts

Cut the remaining piece of copper to the shape outlined in Fig. 3. If four 5/16-in. holes are drilled through the copper where the sections join, ⅝ in. from the center, the cutting to shape will be a simple job. Flatten the end of a piece of No. 8 copper wire, or ⅛-in. copper rod, and drill a ⅛-in. hole about 3/16 in. from the end. Taper the opposite end as shown in Fig. 5.

Drill a ⅛-in. hole in the center of the base and the four-leaf holder. Give each of the four sections of the holder itself a graceful concave form by placing the hammered side on a block of soft wood and shaping with the ball end of a ball-peen hammer. Bend the holder to the shape shown in Fig. 4 and rivet it to the base, with the copper wire in between. The distance between the tops of the sections will depend upon the diameter of the test tube used. The one used by the author is 1 in. in diameter and 6 in. long. Bend the copper wire around the test tube as illustrated above.

The completed holder may be simply polished with steel wool and lacquered, or a very pleasing finish may be obtained by immersing it in a solution of potassium sulphide and water and polishing off the high spots with steel wool after the holder is dry. The length of time to leave the article in the solution may be determined by the color desired. Potassium sulphide loses its strength when exposed to the air, so no definite proportions well be given here. A piece about ½ in. in diameter dissolved in a quart of water should prove satisfactory.

SPECIAL HAMMERS FOR DECORATING METAL



A NOVEL method of decorating sheet-metal projects is by finishing with a hammer whose face is grooved as shown. Anneal the head of a hammer by bringing it to a red heat and allowing to cool slowly, then cut any desired design with a cold chisel or hollow punches. The head may then be taken to a machine shop to have the original temper restored. After hammering, rub the surface with emery.

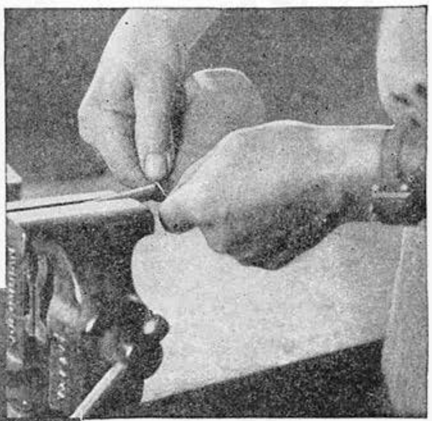
HINTS ON MAKING SALABLE ASH TRAYS

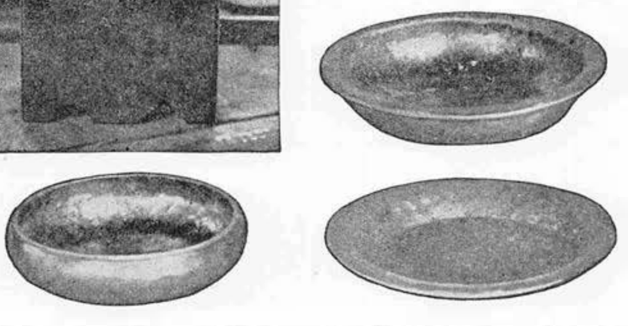
Ash trays are easy to make, are always in demand for gifts and prizes, and it is often possible to sell them at a profit.

If you are a beginner in art-metal work, it will be well to start with lead. Three beaten lead trays are shown below. Each one is made from a disk of 3/32-in. sheet lead 4 in. in diameter, and is hammered into shape with a ball-peen hammer, working from the inside.

The first ash tray in the group at the top of the page is of 18-gage soft sheet copper. It is hammered flat, then bent into shape over a wood block. The second is 22-gage copper. This is not hammered, but is shaped over a ½-in. rod held in the vise as illustrated. The third is brass and the fourth copper. Both are shaped in the same manner as the lead ones.

The lead trays are left plain. The brass one is merely polished and lacquered. The copper trays are colored in a solution made by dissolving a small piece of liver of sulphur in about a quart of water and immersing the trays until they turn brown. Then they are washed, dried, carefully polished, and lacquered.





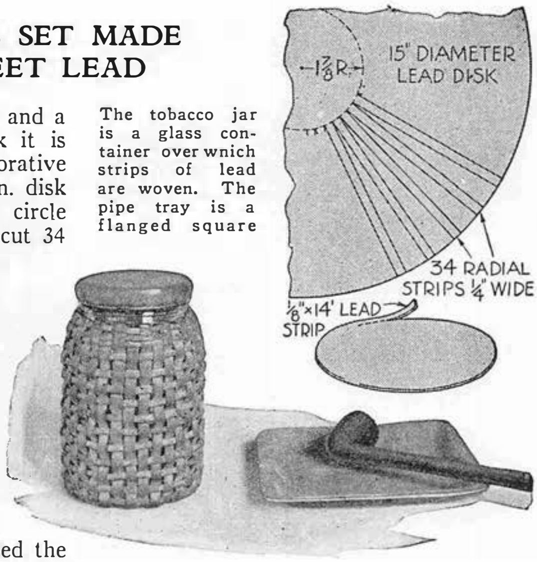
Forming the flutes of the copper ash tray shown second from left in the group at top of the page. *Left:* Hammering tray from lead. *Below:* Group of three lead trays

UNIQUE SMOKER'S SET MADE FROM THIN SHEET LEAD

From a 1-pt. salad dressing jar and a small sheet of lead 1/16-in. thick it is possible to make a novel and decorative pipe smoking set. Lay out a 15-in. disk of lead and scribe a 2¾- or 3-in. circle in the center. Then lay out and cut 34 radial strips ¼-in. wide as shown. Next prepare a ⅛-in. wide strip by cutting around another disk until you have a piece 14 ft. long.

Bind a piece of friction tape around the shoulder of the jar to prevent slipping. Set the jar in the center of the 15-in. pattern and bend every other strip up. Run the ⅛-in. strip around over these; then bend the others up and the first ones out. Repeat until you have reached and rounded the shoulder. Cut off the underneath strips at this point. Run the ⅛-in. strip around again; then bend the others down over this last weave. The cap, 3¾-in. in diameter, is bent up around the tin jar cap against the edge of the bench.

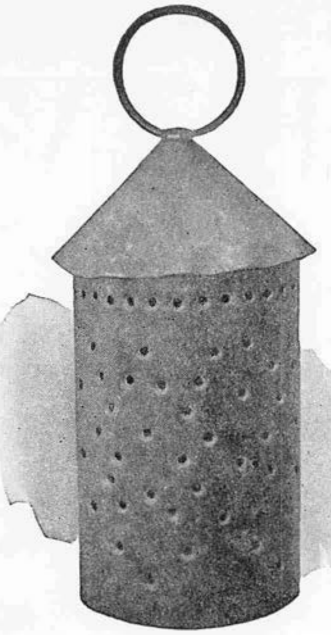
The pipe tray is 6-in. square with the corners rounded. A rim 1-in. wide is bent up all around, and half of this is bent out and pressed down with a piece of softwood.



The tobacco jar is a glass container over wnich strips of lead are woven. The pipe tray is a flanged square

TESTING DOUBTFUL GOLD

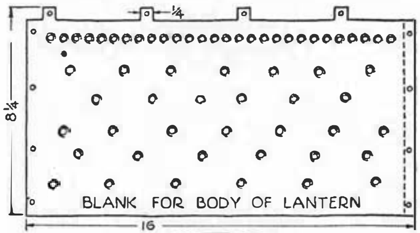
Imitation and spurious gold may be discovered by placing the sample in an air-tight box in which there is a glass or porcelain dish containing a small quantity of iron sulphide. The sulphide is covered with hydrochloric acid, and the box immediately closed. After several hours the sample, if spurious, will be discolored.

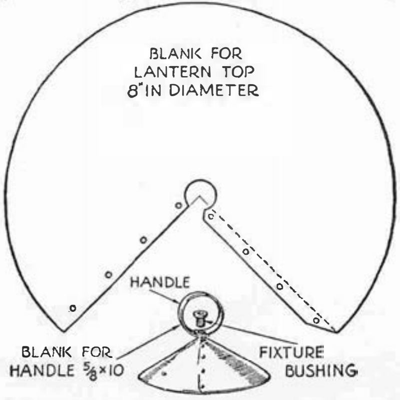


OLD COLONIAL LANTERN IMITATED IN COPPER

To make the body of this replica of an early American lantern, cut a blank 8¼ by 16 in. from 24-gage soft sheet copper, with four lugs on one side as shown. The piece may be merely punched with random holes, or a design may be outlined and punched out. The punching is best done with a sharp-edged nail set on a steel block. When this is completed, roll the piece into a cylinder and rivet or solder the lap joint.

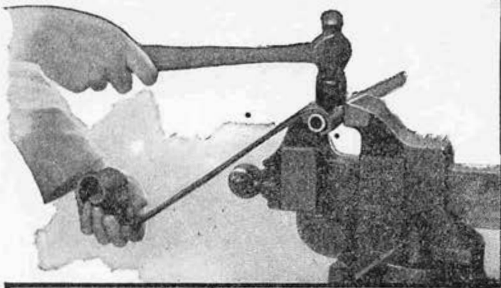
The cap is cut from similar material, bent into shape, and riveted or soldered. Holes are drilled to correspond with those on the lugs, and the two pieces are riveted together with No. 14 brass escutcheon pins. Cut a strip of 16-gage copper ⅝ in. wide by 10 in. long for the handle, bend it into a ring, and rivet the ends together. After drilling a ⅜-in. hole through one side of the ring, attach it to the cap with a ⅜-in. fixture bushing. Leave the lantern in its natural finish and wire it in the usual way.

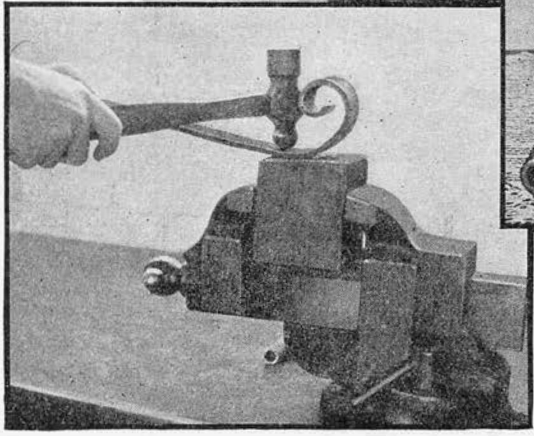


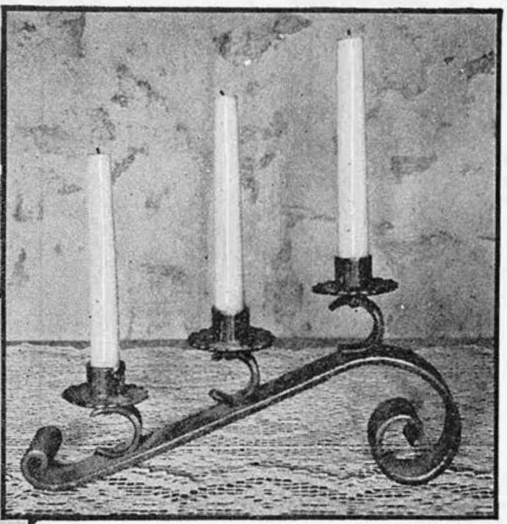


How the blank metal is laid out. The holes may be punched at random or to form a design

Graceful Candlestick Forged at Low Cost from Band Iron

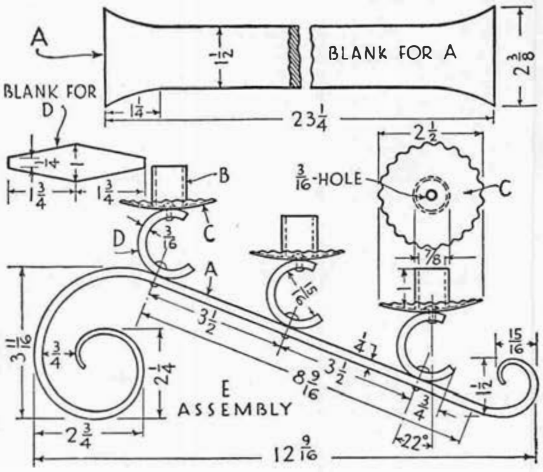






Complete candleholder and, at left, how the scroll ends of the body are bent around a pipe and shaped in the hollow end of a block of wood

The circular plates for each candle socket are scalloped and slightly cupped. *At left:* An assembly drawing and details of the parts



THE use of candles has increased to a great extent during the past few years. While in no way supplanting our modern illuminating systems, they seem to provide just the right atmosphere for intimate, informal gatherings and dinners. The candleholder illustrated is easy to construct and can be made by the home craftsman at very low cost.

The body is made from a piece of band iron ¼ by 1½ by 22¼ in. The ends should be heated and flared to a width of 2⅜ in., as shown at *A* in the drawings. To enhance its appearance, the body should be closely peened with a hammer, as should all of the separate parts before the assembly. After the body has been flared and peened, the length should be about 23¼ in. A slight variation in this length will not affect the general appearance.

The scroll ends on the body are formed by bending around a piece of pipe and by shaping in the hollow end of a block of wood, as shown in the photographs. The ends of the iron should be heated to a cherry red color before the bending is attempted.

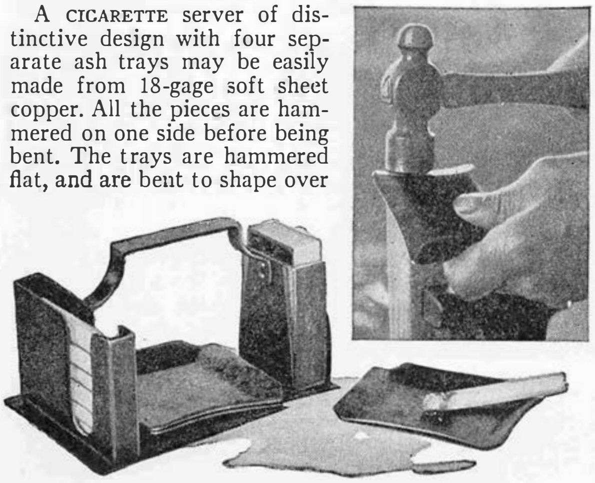
The details of the individual candleholders are shown at *B*, *C*, and *D*. The cylinder *B* is formed around a piece of ½-in. pipe from a blank of 14-gage galvanized sheet iron 1 by 2⅝ in. The joint is brazed or soldered. Since there is a tendency for light metals to expand during the peening process, the piece should be peened and then finished to the size shown before it is formed into a cylinder. The edges of the circular plate shown at *C* should be scalloped as indicated, but do not attempt to make the scallops symmetrical. The plate should be slightly cupped by hammering it against a block of wood. The crescent shaped piece *D* is formed around a piece of 1-in. pipe. The cylindrical piece *B* may be either soldered or brazed to the plate *C*. The individual parts are secured together and to the main body with 3/16-in. iron rivets. The assembly is shown at *E* in the drawings.

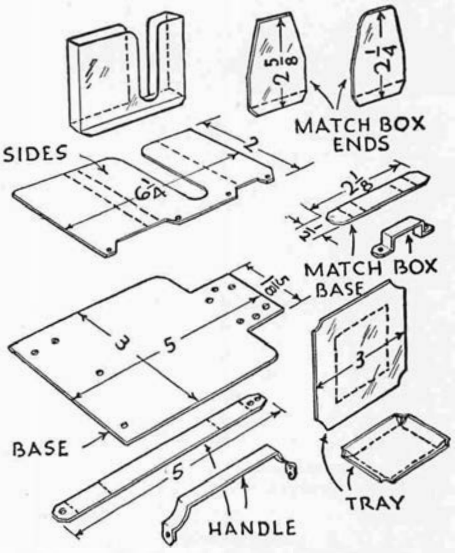
The completed holder may be finished in a variety of ways, or it may be left unfinished. The holder shown in the photograph is finished with flat black paint, which gives a pleasing appearance. This is the conventional—and always satisfactory—finish for iron.

AFTER-DINNER SERVER FOR CIGARETTES

A CIGARETTE server of distinctive design with four separate ash trays may be easily made from 18-gage soft sheet copper. All the pieces are hammered on one side before being bent. The trays are hammered flat, and are bent to shape over a wooden block, which is held in the vise as shown.

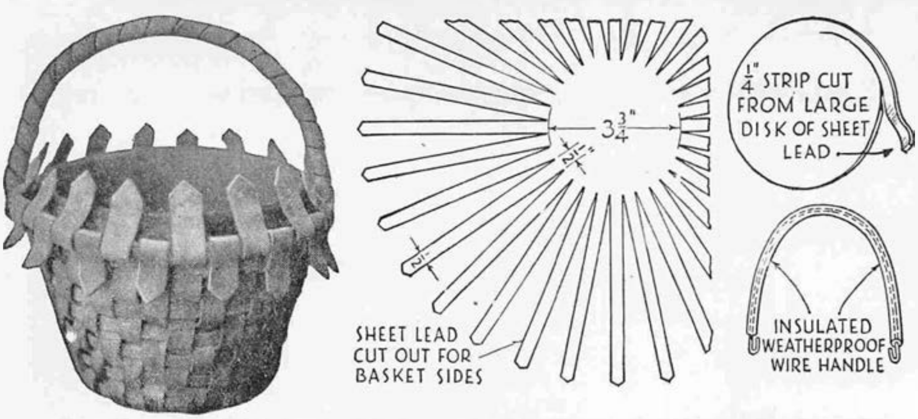
Rivet the parts together with No. 14 brass escutcheon pins. The pieces are colored after they have been assembled. Dissolve a small bit of liver of sulphur in about a quart of water; then, after washing the trays and holder thoroughly in soap and water, immerse them in the solution until they turn brown. Finally wash, dry, polish, and lacquer them. Use a clear brushing lacquer or a lacquer sold for protecting polished metal from tarnishing.





Sketches of parts for the cigarette server

FLOWER BASKET WOVEN FROM LEAD


3 3/4"
1/2"
1/2"
1/4" STRIP CUT FROM LARGE DISK OF SHEET LEAD
SHEET LEAD CUT OUT FOR BASKET SIDES
INSULATED WEATHERPROOF WIRE HANDLE

Although it resembles a basket, this flowerpot holder is made from sheet lead. A disk of the lead is cut into a number of radial strips, and a long, narrow strip is woven around them

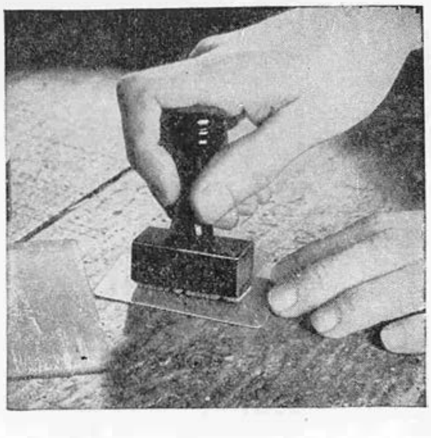
THIS unique flower basket is made of sheet lead with no other tools than a pair of shears and your fingers. The lead should be about 1/16 in. thick. You can obtain it from your plumber, and in some of the larger cities it can be bought at department stores, now that craft work in sheet lead has become popular.

A disk of lead 15 in. in diameter will cover a flowerpot 4 in. deep, 5½ in. in diameter at the top, and 3¼ in. at the bottom. If pots of other sizes are used, the drawings may still be followed provided an allowance is made for the difference in bottom diameter and the side strips are cut about one third longer than the height of the jar.

Draw the outer circle (in this case 15 in. in diameter) on a sheet of the lead, and in the center of this scribe a circle 3¾ in. in diameter. Divide the latter into ½-in. spaces and complete the layout, only a part of which is shown to save space. Then cut out the blank with a pair of shears. From another disk, cut a ¼-in. strip around and around until you have a piece about 12 ft. long.

Lay the basket blank on the table and bend every other strip straight up. Bend the ¼ in. wide strip around these at the bottom; then bend the remaining strips up, and the others out. Work around in this manner until the weaving is completed. The photograph shows how the top is treated. The handle is a 12-in. length of insulated weatherproof wire. Bare the ends and bend them around the top strand of the basket. Then wind a ½-in. strip of lead around the wire.

If it is desired to have a saucer or tray inside the basket on which to set the flowerpot so that water will not leak out, make an allowance for this in drawing the layout.



ETCHING NAME PLATES

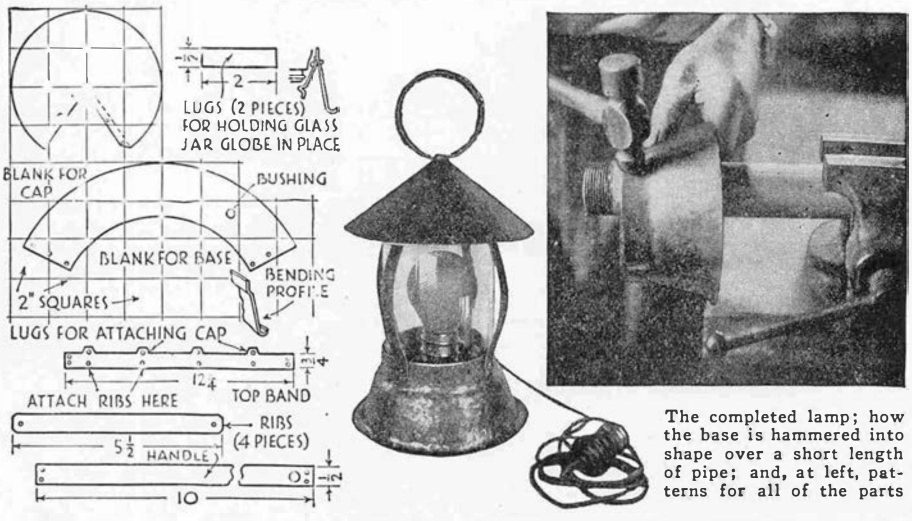
IF YOU have a rubber stamp for reproducing your name and address, you can use it for making novel copper for brass plates suitable for labeling boxes, luggage, models, and the like. Clean the stamp with soap and water until the rubber characters are free of ink and lint. Melt a small quantity of paraffin on a warm piece of scrap metal, press the rubber stamp against it, and quickly make an impression on the plate you wish to etch. This plate must be perfectly clean, and it should be slightly warm.

Place the plate in the etching solution, which can be made by mixing 1 part of concentrated nitric acid with about 8 parts of water. Let the acid act for a few minutes only, or just long enough to produce an even matte surface. Longer action usually results in the acid's working through the wax letters. Finally, wash the plate, scrape or melt off the wax, and mount.

AMMONIA GIVES COPPER A DARK FINISH

ONE way of producing an antique finish on hammered copper work is to suspend it for several hours in a closed container having strong ammonia water at the bottom. A small fish bowl or fruit jar is suitable for most work. Clean the article well, removing every trace of grease from its surface. Then suspend it in the container so that it does not touch the ammonia water. The action of the fumes will cause the metal to turn dark and take on various shades of green, blue, and brown. Remove the article from the jar, polish with a cloth, and apply wax, lacquer, or whatever other finish you desire; or just leave the metal as it is.

SALAD JAR FORMS GLOBE OF LANTERN



The completed lamp; how the base is hammered into shape over a short length of pipe; and, at left, patterns for all of the parts

ALL pieces for this decorative lantern-type lamp are of 22-gage soft sheet copper except the handle, which is 18-gage. Each part is hammered on one side.

Roll the base into a conical shape, and rivet the lapped joint with escutcheon pins. Place a short length of pipe in the vise, and hammer the base into shape as illustrated in one of the photographs. Expand the top to 3⅞ in. in diameter, and roll up the bottom slightly. Then roll and rivet the top band, and rivet the four ribs to this. Shape the cap, drill four holes in it to match the lugs, and rivet the top band in place. Next rivet the ribs to the base. Shape the handle and rivet it on. After drilling holes through this and through the top of the cap, bolt the handle in place.

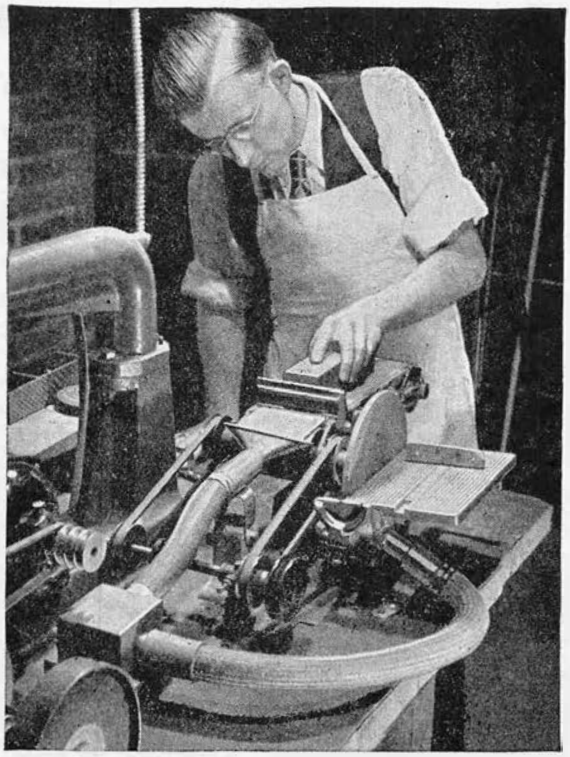
Take a quart salad-dressing jar and drill a ⅜-in. hole through the center of cap. Attach a light socket so that it will come on the inside of the jar. Wire with a drop cord. Place the cap on the jar and insert the jar in the lamp upside down. Then rivet in the lugs to hold the jar in place. Run the cord out through a fiber bushing.

WORKSHOP HINTS

EASILY INSTALLED

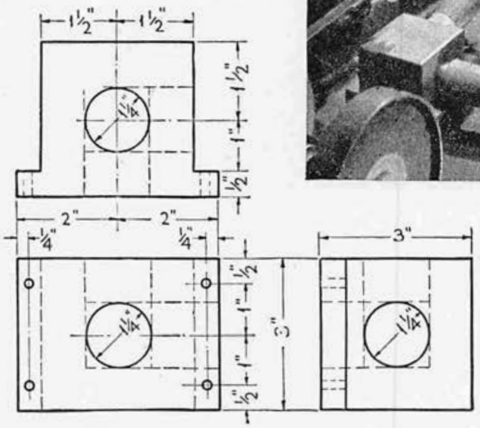
Vacuum System

FREES SHOP OF DUST

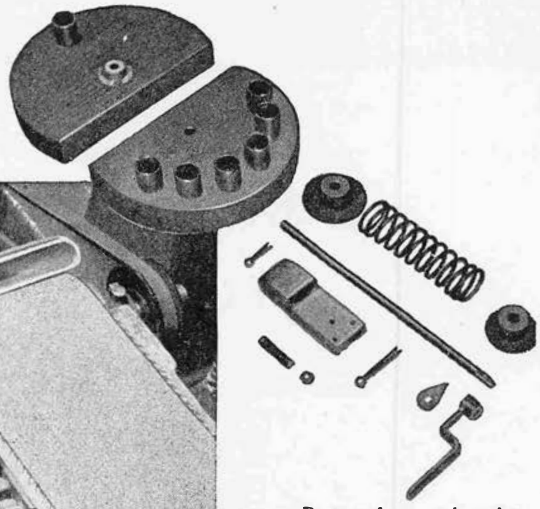


Combination belt and disk sander being used in a dust-free workshop. The vacuum hose leads from each section of the machine to a three-way block, made as shown at left

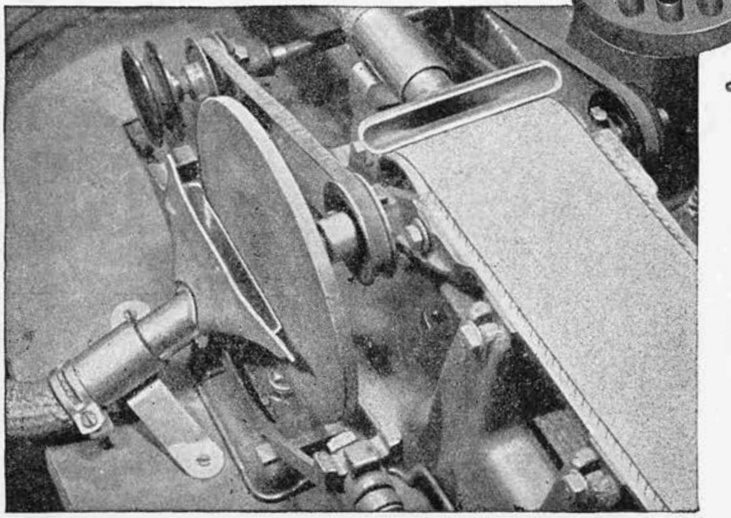
HOW often have you wished for a continually clean power bench and tools instead of a pile of sawdust or shavings around each machine? You may have this and more by installing an efficient and easily built vacuum system of the type illustrated. This does a remarkable job of removing all sawdust at its source. It is also beneficial from a health standpoint, as the air is free from the clouds of dust that otherwise are always arising from the various power tools.



First, obtain a straight suction type vacuum-cleaner unit, either by purchasing a second-hand or rebuilt one, or borrowing the one in your home. The average housewife uses her vacuum cleaner about once a week. To use it between times in the workshop takes only about a minute to remove the handle and mount it in place by slipping four loops of cord over the wheels. The standard bag may be used, although you can make a larger bag to hold more sawdust.



Parts of control valve for the entire system. The assembled valve is shown on the next page

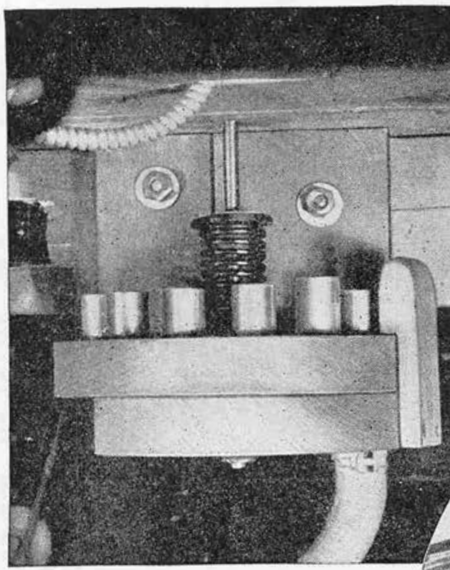


Standard vacuum-cleaner nozzles are used to trap the dust from both the belt and the disk of the small combination sander

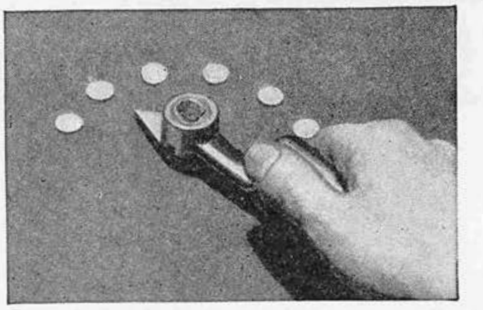
The pipe lines leading to the power tools may be standard vacuum-cleaner hose or standard steam hose. The former is obtained from your electrical dealer at about $2.25 for an 8-ft. length. The steam hose is sold at hardware stores for about 25 cents a foot. The sizes in this article are for hose of 1¼-in. inside diameter. For hose of different diameters, allow accordingly.

To obtain maximum suction at the vantage point of each machine, it will be necessary to construct a control valve. The parts of this are shown at the left, and the assembled valve on the following page. The smaller spring, which is of ½-in. diameter, and the larger spring, the size of which is not important, may be obtained for a few cents at a junk yard or a hardware store.

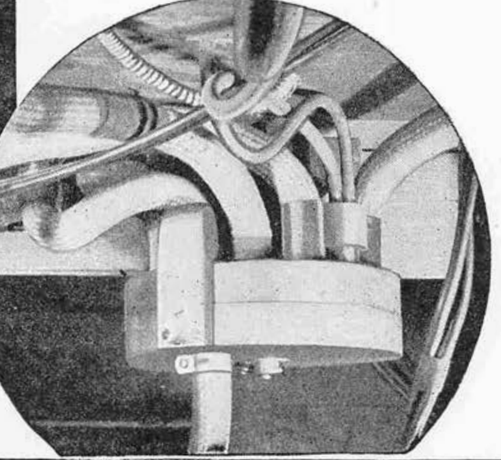
Lay out the two valve blocks on a close-grained wood and saw them out. Plane and sand the valve faces so that they



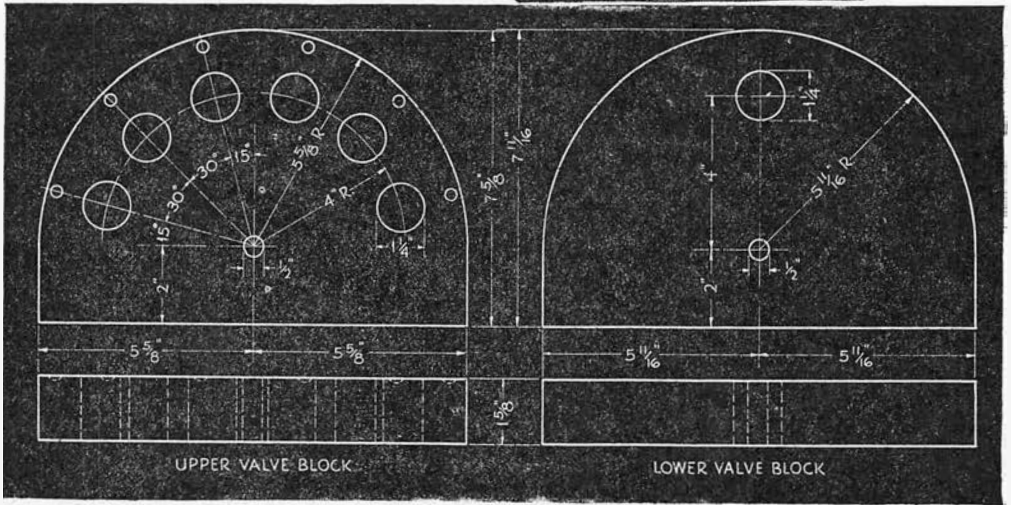
The assembled control valve is fastened by means of a wooden bracket beneath the bench. The lower valve block turns to connect the vacuum cleaner with any machine



The valve handle is above the bench top. Dowels are set into the bench as markers to indicate the position for applying suction to each machine



At right is another view of the control valve with the hose from the different machines in place. The two small tubes come from above and below the jig saw



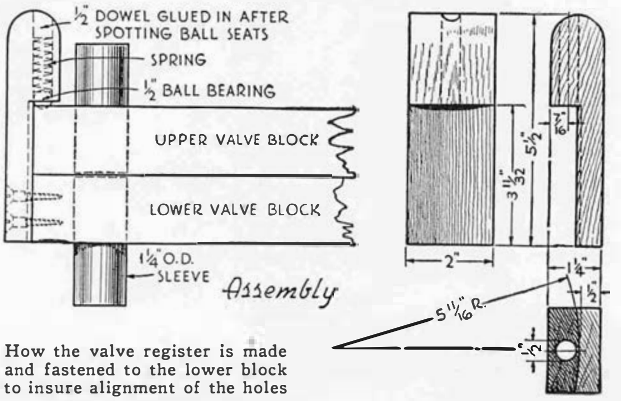
Top and edge views of the upper and lower valve blocks. These parts are made of close-grained wood, and the faces must be smooth and true in order to prevent leakage of air. The assembly is shown in the photos above

are smooth and true. It is imperative that these faces be true and remain so, as air leaks at this point will impair the efficiency of the system.

With an expansion bit, drill the 1¼-in. hole in the lower valve block. When boring the portholes, set the bit a trifle undersize to assure a press fit when the sleeves are assembled. Next, clamp the valve blocks together in their correct relation to each other and drill the ½-in. hole through the center of both. Insert a short piece of ½-in. diameter shaft through this hole and remove the clamps. The two pieces will now rotate about their common axis. You may now assure a perfect registration of the valve ports by using the porthole in the lower valve block as a jig for drilling the portholes in the upper valve block.

For the valve blocks to remain true, they must be treated to prevent warping. You may readily do this by sizing them with an application of thin, hot glue well rubbed in, or if you prefer, boiling them in paraffin for about ten minutes. Resand the faces with fine sandpaper and lay aside while proceeding with the next step.

From a piece of scrap wood construct the valve register and screw it to the lower valve block as shown in the drawing. Assemble the two valve blocks with the ½-in. diameter pin, and insert a ½-in. drill through the hole in the valve register. Upon the perfect registration of each valve port, make a small seat in the upper valve block with the drill point. This is the seat that the spring-loaded ball bearing will drop into to denote registration. Remove the drill and drop the ½-in. ball and spring into the hole. Insert a ½-in. dowel stick and compress the spring until sufficient pressure is exerted to hold the outer edges of the blocks firmly together. Mark the dowel, glue in place, and cut off flush with the top. Make the sleeves of 1⅛-in. inside diameter by 1¼-in. outside diameter tubing, 3 in. long, and press into the portholes.



How the valve register is made and fastened to the lower block to insure alignment of the holes

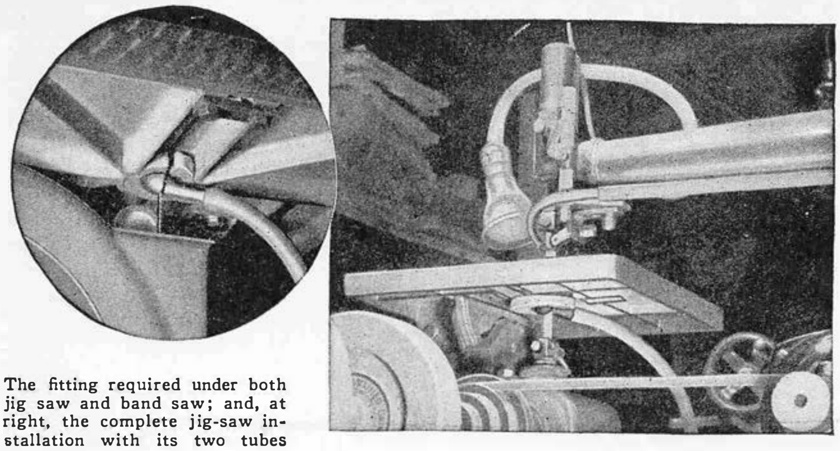
The next thing to consider is the location of the valve on the bench. Select a place that is most convenient to all machines. Construct the valve bracket so there is at least 7 in. clearance between the upper valve block and the underside of the bench. Screw the lower part of the bracket to the upper valve block and attach them in place under the bench. Cut the ½-in. diameter steel shaft and insert through the valve block until it hits the underside of the bench. Tap the shaft lightly with a mallet until an indication is made for drilling the hole in the bench.

Now visit the scrap pile for a piece of metal, preferably flange shaped although not necessarily so. This is for fastening the shaft to the lower valve block so they will rotate together. Drill the shaft and screw holes and fasten it securely to the lower valve block. Drill the shaft and flange together, and fasten with a cotter pin.

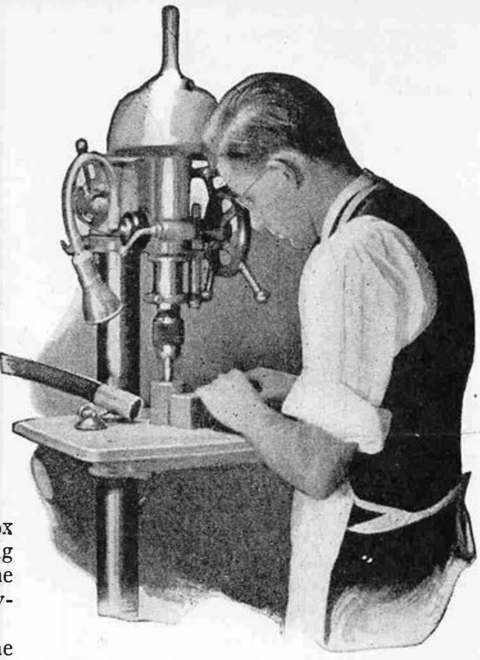
Make a wooden retainer for each end of the large spring. Place the spring and retainers over the shaft with large washers at both ends. Compress the spring so that the blocks are held firmly together, and drill a cotter-pin hole at this point. Assemble the complete valve and provide some type of control handle. This may be made as desired from any material at hand. Lay out and drill marker holes on top of the bench, and insert dowel pins cut off flush with the top.

Mount the vacuum unit in a suitable position such as shown in a photograph on the following page. Connect it so that it operates in conjunction with the desired motors.

Valve connections to the various ma-



The fitting required under both jig saw and band saw; and, at right, the complete jig-saw installation with its two tubes

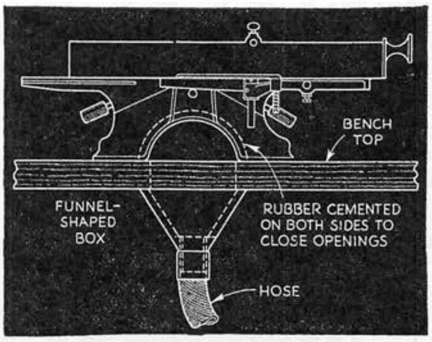


On the drill press the nozzle is held in any position necessary by means of vacuum cups

chines are arranged in the following way:

Circular saw. Remove the saw table and construct a wooden chute as shown. Cut the top at a 45-deg. angle so that it will not interfere when the table is tilted. Carefully mark where the blade will go through the side, and saw the slot so that it will just clear the blade at the sides and in its extreme lowered position. Next, as shown, cut out a piece of the side, hinge it back in position, and lock it with a wood screw. Drill a 1¼-in. hole through the bottom of the chute and bench top for the sleeve. Cement pieces of rubber on all four sides from the chute top to the underside of the saw table.

Jointer. Cut a rectangular hole through the bench top directly under the knives. Construct a shallow funnel-shaped box and mount it as indicated in the drawing below. Close up all the openings at the sides or ends of the planer with light plywood or rubber, cemented in place.



A funnel-shaped box is constructed underneath the jointer to remove all the shavings as they are made

Jig saw and band saw. Remove the jig-saw table and place it upside down on the bench. Cut off the top of the bowl of an old straight-stemmed smoking pipe. Enlarge the stem hole as much as possible without cracking it. Cut a slot about three quarters through the pipe in the correct position for the saw blade.

From the ten-cent store obtain a sponge-rubber kneeling pad and several feet of ⅜-in. inside diameter by ½-in. outside diameter rubber tubing. Cut a 3-in. diameter sponge rubber circle with a hole through the center slightly smaller than the outside diameter of the pipe. Cement the pad in position on the underside of the table (as shown in the circle above) and insert the pipe. After replacing the table on the jig-saw, slip the rubber tubing over the stem. Run the tubing through the bench top to the valve.

For the top of the table bend a short piece of ½-in. copper tubing as shown in another photograph at the top of this page. Solder a terminal to it so that it may be fastened under a convenient nut. Slip a piece of the rubber tubing over the end and cement it in place along the frame. Run it through the bench.

Make a wooden cap to fit over one sleeve of the control valve. Drill two holes through the top of the cap for short pieces of ½-in. outside diameter copper tubing. Assemble and place the two ends of rubber tubing over the copper sleeves.

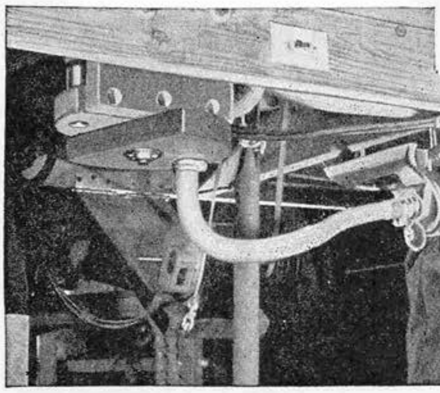
In equipping the band saw, follow the same procedure as for the lower part of the jig saw.

Sander. As this particular machine is in two sections, belt and disk, it may be connected to the valve in two ways—a separate hose to the valve for each, or as shown on page 61 with a three-way block and a single port on the valve.

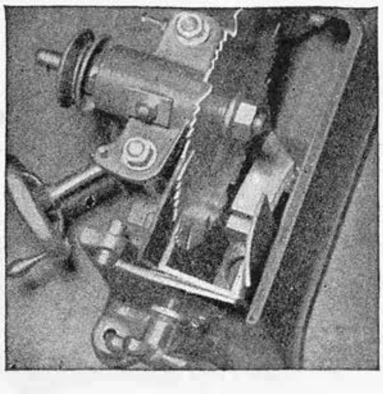
Mount the nozzle to the sanding disk about 2 in. below the table and build up to the table with inner-tube rubber cemented in place.

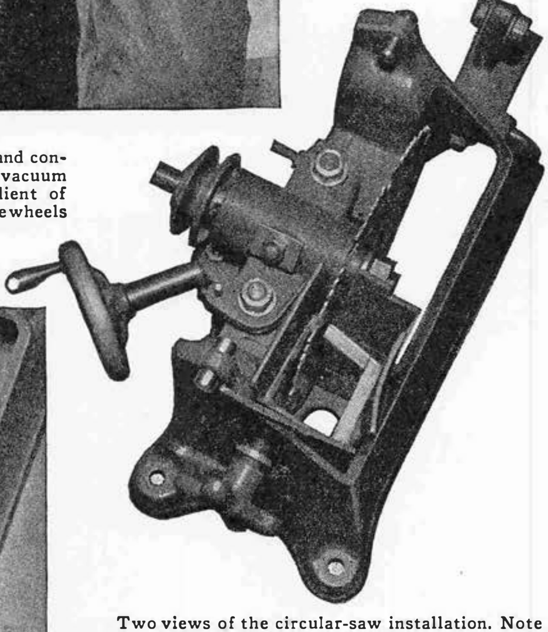
Drill press. Obtain two suction-cup coat hangers from the ten-cent store and remove the cups. Construct a bracket to hold the end of a hose and mount the suction cups as shown in a photograph.

General purposes. Place an outlet on the bench where convenient.



A general view of the vacuum cleaner and control valve under the bench top. The vacuum unit is mounted by the simple expedient of slipping four loops of strong cord over the wheels





Two views of the circular-saw installation. Note that one side of the chute is hinged for removing the saw and using a dado. Rubber is cemented to top of chute to extend it to the saw-table proper

Check Your Shop Lighting

WHEN you tackle a job in your home workshop, do you make frequent mistakes, bruise and cut your fingers, and emerge in an hour or two with a headache? If you do any or all of these things, the chances are that there is something wrong with the shop lighting system.

"Oh, I doubt that," you may say to yourself. "Besides, I have a big bulb right over my bench, and the shop looks to be pretty well lighted."

All right, test the light for yourself and see just how good it is. If it is nighttime, stop reading right away and take this book to the basement, or wherever you have your shop. Lay it open on your bench so that the chart on the opposite page is in the position where you do most of your work. This chart has been especially worked out to serve as an easy and practical test of home workshop illumination.

Now lean over until your head is at your normal reading distance from the chart, and try to read the smallest type—that in the upper right-hand corner. Then look at the small drawing directly at the left of the type. Can you make out all the lines, distinguish the separate parts, and read the dimensions and identifying letters?

If you can do all this correctly and easily, without any special straining, your bench is very well lighted at this particular point. There may be other things wrong with the lighting, such as glare, the casting of violent shadows, and the lack of proper reflectors and shades, but the amount of light certainly is sufficient.

If you don't have much luck with the first sample on the test chart, try the second. Study both the drawing and the accompanying type. If both are easily read, the illumination at this point of your bench is good.

Try the third division of the chart. It can be read comfortably in what may be called "fair" illumination, but this is not good enough for a workbench, especially when accurate or delicate work has to be done, such as fitting furniture joints or making models. Neither is it adequate for working from small drawings of the type published in magazines and books or for studying blueprints that contain fine lines and intricate details.

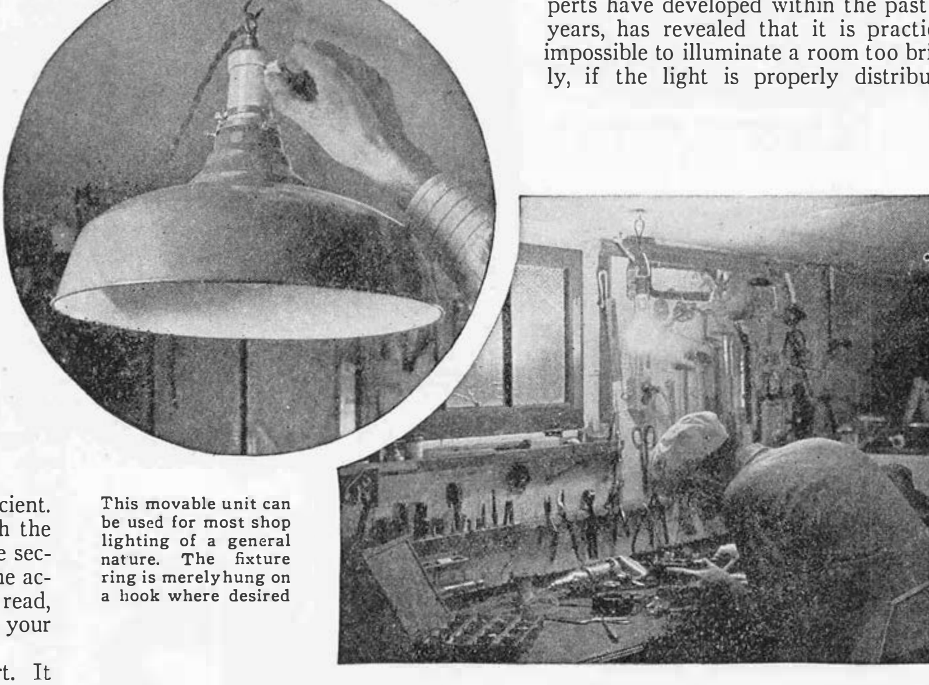
Many home workshops do not have even this degree of illumination. If you find that you have to go as far as the fourth test specimen to make out the letters and figures quickly and clearly, there is no question about the inadequacy of the illumination. It is poor. In fairness to yourself, you should do no further work at the bench until you have improved the lighting.

You may use the chart in the same way at your machines, if you have any, or in other positions in the shop. Provided you are conscientious in using it, the chart will give a rough-and-ready but satisfactory check. For a more accurate and scientific test, lighting engineers use a sensitive instrument known as a "sight meter." Your own lighting company will probably be glad to send a representative to your home with one of these meters to test all your lighting facilities, if you wish.

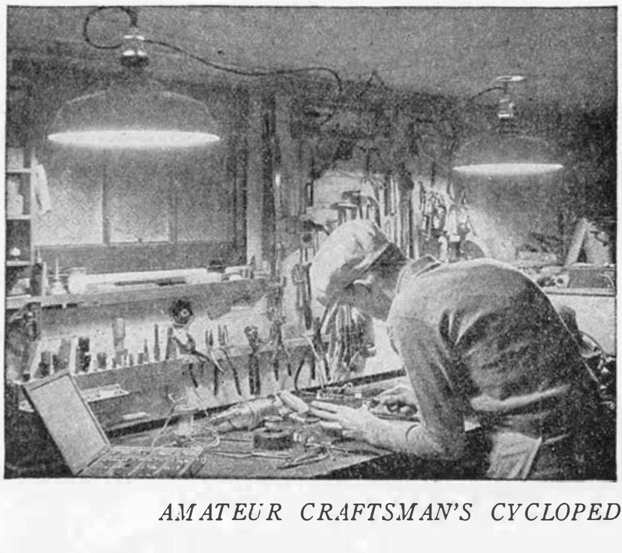
Plenty of light, properly distributed, is the best insurance against accidents, bungled work, and damage to eyesight in the home workshop, according to experienced illuminating engineers.

Most workshops are underlighted, particularly those in which dark-colored tools and materials are used. Engineers measure lighting intensity in foot-candles. In too many shops, the value of the light on a workbench top is scarcely more than 1 or 2 foot-candles, whereas the recommended minimum is 15. Outside sunlight reaches values of many thousand foot-candles, so that you need have no fear of getting too much light. The new so-called "science of seeing," which lighting and vision experts have developed within the past few years, has revealed that it is practically impossible to illuminate a room too brightly, if the light is properly distributed;

You Will Do Better Work . . . Save Yourself from Eyestrain . . . and Reduce the Risk of Accidents



This movable unit can be used for most shop lighting of a general nature. The fixture ring is merely hung on a hook where desired



It is a great strain to work in any shop lighted like the upper one at the right. The bench should be illuminated, as shown in the lower view, by two modern 14-in. domes with 150-watt lamps

with New Test Chart

and that increasing the amount of light actually prevents the eyes from becoming tired as rapidly as with lower intensities.

Even worse than too little light is glaring light. A 10-watt bulb, unshaded and suspended in front of the face where its rays shine directly into the eyes, can be painful and will cause partial blindness no matter how much other illumination is present. Glare, then, is to be guarded against. In fact, it is the principal bugbear of modern lighting systems, and sometimes is difficult to eliminate. In addition to direct glare from a lamp, reflected glare from polished metal surfaces must be avoided.

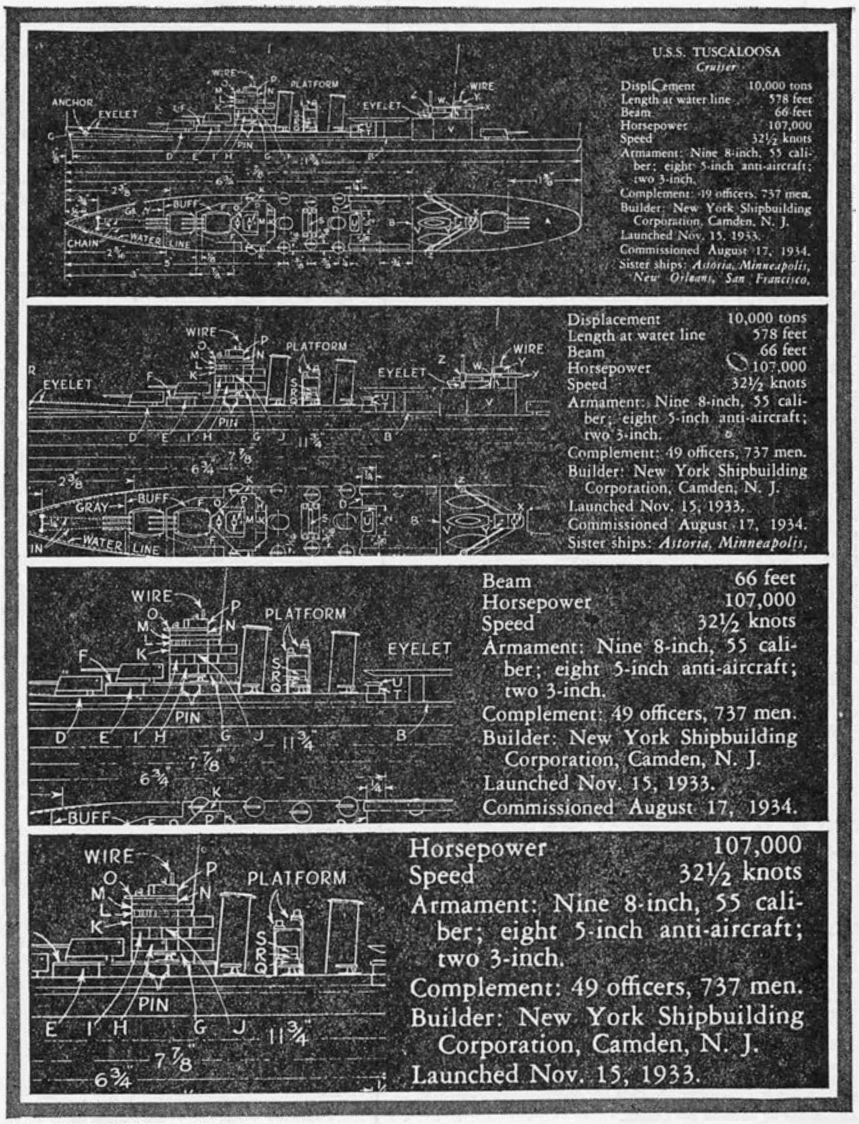
Shadows, too, have to be taken into consideration. In some types of shop work they are necessary to reveal objects in three dimensions; but when most of the work is concerned with length and breadth only, shadowless lighting is preferable. When shadows are desirable, they should be soft and luminous.

"How can I meet all these conditions?" you ask, perhaps thinking it next to impossible to do so.

Take a concrete example: Suppose that you have a workbench 3 ft. high and measuring 3 by 8 ft. on top, and that the room has a ceiling 7 ft. above the floor. This is a good average for basement shop conditions. You desire to light the bench in the most approved manner.

A sufficient amount of light, it is calculated, when dealing with the ordinary home workshop, will be provided by two 150-watt, frosted-bowl lamps in standard 14-in. R.L.M. domes, spaced 5 ft. apart and 2½ to 3 ft. above the surface of the bench. R.L.M. is a trade designation for the type of dome illustrated, although what it really stands for is "recommended by lamp manufacturers." These lighting units should be placed so that their centers are 6 in. back of a vertical line extending from the front edge of the bench, and 2½ ft. on either side of a line drawn across the center of the bench. They measure about 1 ft. high over all.

The R.L.M. domes are metal reflectors enameled green on the outside and white inside. They are scientifically shaped for the most efficient distribution of light. The porcelain, which is baked on, is easy to clean; and it and the bulb should be kept clean at all times if you want the most light for your money. R.L.M. reflectors are made by various manufacturers.


WIRE
PLATFORM
WIRE
ANCHOR
EYELET
EYELET
PIN
BUFF
GRAY
WATER LINE
CHAIN
O
M
L
K
P
N
F
S
R
Q
D
E
I
H
G
J
B
11¾
7⅞
6¾
2⅜

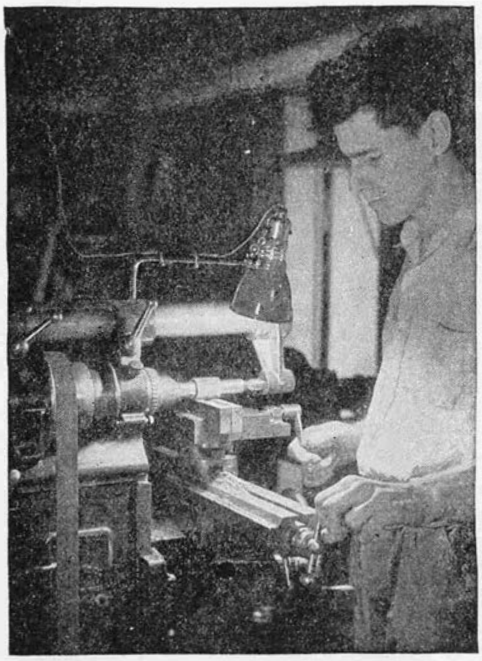
U.S.S. TUSCALOOSA
Cruiser
Displacement 10,000 tons
Length at water line 578 feet
Beam 66 feet
Horsepower 107,000
Speed 32½ knots
Armament: Nine 8-inch, 55 caliber; eight 5-inch anti-aircraft; two 3-inch.
Complement: 49 officers, 737 men.
Builder: New York Shipbuilding Corporation, Camden, N. J.
Launched Nov. 15, 1933.
Commissioned August 17, 1934.
Sister ships: *Astoria, Minneapolis, New Orleans, San Francisco,*

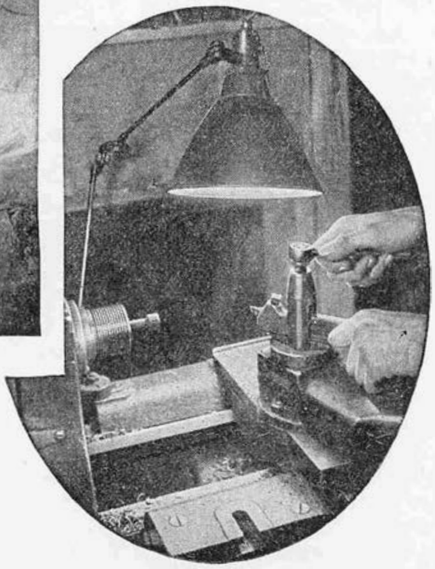
Displacement 10,000 tons
Length at water line 578 feet
Beam 66 feet
Horsepower 107,000
Speed 32½ knots
Armament: Nine 8-inch, 55 caliber; eight 5-inch anti-aircraft; two 3-inch.
Complement: 49 officers, 737 men.
Builder: New York Shipbuilding Corporation, Camden, N. J.
Launched Nov. 15, 1933.
Commissioned August 17, 1934.
Sister ships: *Astoria, Minneapolis,*

Beam 66 feet
Horsepower 107,000
Speed 32½ knots
Armament: Nine 8-inch, 55 caliber; eight 5-inch anti-aircraft; two 3-inch.
Complement: 49 officers, 737 men.
Builder: New York Shipbuilding Corporation, Camden, N. J.
Launched Nov. 15, 1933.
Commissioned August 17, 1934.

Horsepower 107,000
Speed 32½ knots
Armament: Nine 8-inch, 55 caliber; eight 5-inch anti-aircraft; two 3-inch.
Complement: 49 officers, 737 men.
Builder: New York Shipbuilding Corporation, Camden, N. J.
Launched Nov. 15, 1933.

This chart will show whether you have excellent, good, fair, or poor light in your shop





You will find it a pleasure to work with shop machines that are equipped with their own lights in suitable reflectors. The milling machine above has an adjustable unit costing $1.50 for the parts. It is adaptable to most machines. In the oval is a 150-watt lamp mounted on a swinging arm for illuminating lathe work properly

You may hesitate at the first cost of installing them, but they will last for years.

"Why not use a single 300-watt lamp over the bench, and save the cost of one reflector and socket?" you may ask. The reason for using two lamps of equal size is that they give nearly shadowless lighting, which is best for most bench work, whereas a single bulb throws confusing shadows.

WHEN the lamps are placed higher than 2½ ft. above the bench, they can be suspended directly over the front edge. Also, if much work is to be done in a vise that projects out from the bench, the lamp should be placed a little farther forward than the 6-in. position.

For lathes and similar machines, a single 150-watt lamp unit, suspended a little to the right of the faceplate end of the headstock spindle, generally is satisfactory. It is convenient, you will find, to mount a lathe lamp on a swinging arm, and provide some means of adjusting the height as well as the lateral position.

There is a way in which a single lighting unit employing an R.L.M. dome can be made to do the work of several. Obtain a key socket, preferably one made of porcelain, that is threaded for a standard fixture ring. With the ring screwed securely in the socket, the unit can be suspended from a small hook; and the hooks can be distributed over the shop so that the light can be moved where it will do the most good. Of course, you will have to provide sufficient wire to permit shifting. Use rubber-covered cord and a rubber-jacketed plug. A lamp of this type is better, in most cases, than the more familiar but generally less efficient extension unit.

It is convenient to have a localized source of light on drill presses, band saws, jig saws, and almost every other shop machine. Then there is no trouble in directing light where it will do the most good. A 25- to 40-watt bulb is large enough for machine lights. It must be shielded by a reflector that will direct the light on the work, yet will not be too bulky.

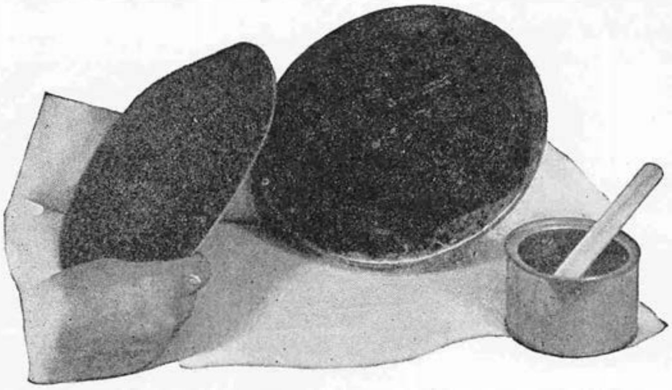
The unit illustrated in use on a milling machine has a reflector of the approved type. Made of metal, with baked-on enamel finish, it fits snugly about the bulb and has no useless bulk. The shade shown is priced at 90 cents, and the chromium-plated socket, cord, and plug cost 35 cents additional. The unit is fastened by a ball-and-socket arrangement that formerly was part of a 25-cent clamp for portable fixtures such as those sometimes employed by photographers. However, you can make a simple bracket by bending a narrow strip of metal around the socket, clamping it with a small bolt running through holes, and drilling the protruding 2- or 3-in. portion so that it can be fastened by a bolt already on the machine, or one put there for that purpose.

Another convenient lighting gadget for the shop is a small bulb attached to the end of a flexible lamp cord so that it can be let into holes and restricted places where light from ordinary sources cannot be directed. A 6-volt radio dial lamp, energized by a doorbell transformer, will serve nicely.

Another still more portable unit consists of a flash-light bulb on the end of a pair of flexible wires, connected to a standard battery case. For similar purposes a useful lamp is the 110-volt S-6 Mazda.

CEMENTING SANDPAPER TO METAL DISK

VARIOUS adhesives are used by amateur craftsmen to attach sanding disks to the metal plates that are now so commonly used for disk-sanding operations. Among them are shellac, collodion, glue, and plastic metal cements of different types. None, however, seem to give entirely satisfactory results, and you will find that a mixture of rosin and castor oil will do the trick. The rosin is melted in a tin can, and about one third of its volume of castor oil is stirred into it. The metal disk is warmed over a flame for half a minute or so if it is cold, and the mixture is smeared over it. The disk of garnet paper or other abrasive is applied immediately, and the whole is set face down on the floor and weighted. The disk is ready for use as soon as it has cooled. It will stand up under exceptional use.



For attaching garnet paper or other abrasives to a metal sanding disk, a hot mixture of rosin and castor oil makes a good adhesive

HOW TO MAKE YOUR OWN BLUEPRINTS

BLUEPRINTS are well known as a means of reproducing mechanical drawings, and they are also very useful as a cheap method of making bookplates, circulars, and other designs in limited quantities. The first thing that is needed is a tracing of the design to be reproduced, either on translucent paper, or on regular draftsman's tracing cloth. This should be made with opaque black drawing ink.

The blueprint paper can be purchased quite cheaply, but many users prefer to make their own. To do so, prepare two solutions as follows:

A.—Iron Ammonia Citrate	15 drams
Distilled Water	4 ounces
B.—Potassium Ferricyanide	10 drams
Distilled Water	4 ounces

Mix these solutions just before using, and apply to the surface of the paper with a soft brush. From this stage on, the paper must be protected from the light. Do the mixing in a dark room, and hang the sheets in a closet or similar place to dry. To make the prints, put a sheet of the blueprint paper on a flat board, place the tracing over it, and cover with a sheet of glass. The whole assembly may be kept together with one or two rubber bands. Expose to sunlight for two or three minutes, then immerse the paper in water until the image is clear. The print can be improved by soaking in dilute hydrochloric acid for a few minutes, after which it must be well soaked in water before it is allowed to dry.

Blueprint paper can also be used to make prints from photographic negatives, and is a cheap way of introducing children to the mysteries of photography.

RACK FOR PUNCHES MADE BY BORING INTO SHELF

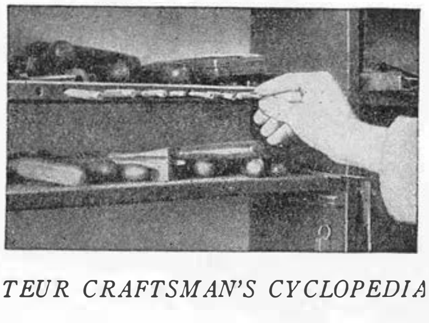
WHERE wooden shelves are used over the workbench, a series of small holes may be bored into the edge of the shelving on a slight downward slant to hold punches, nail sets, and various small round tools. It is then easy to select the tool wanted without delay.

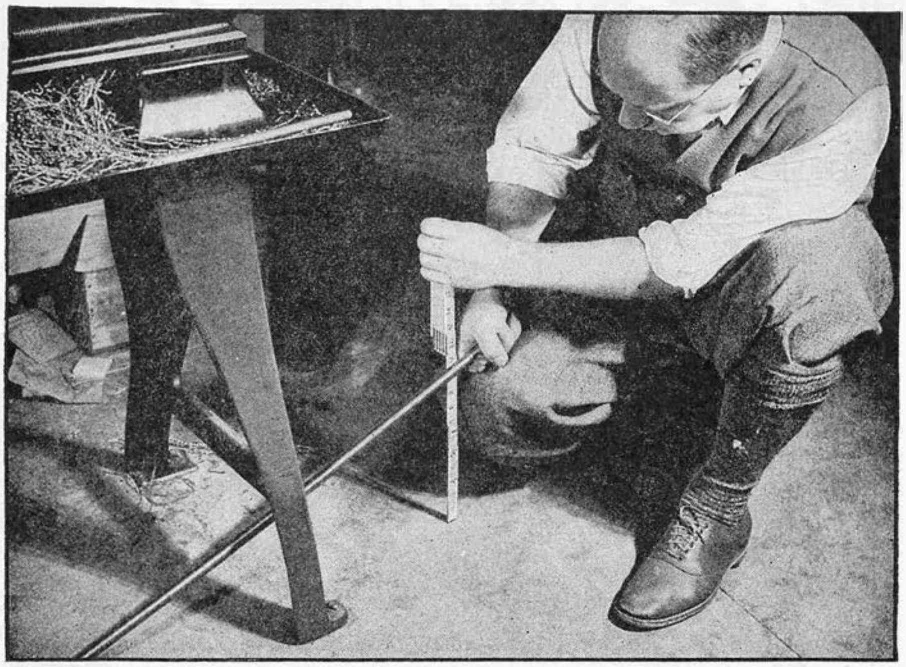
SOLUTION REMOVES ALL RUST FROM TOOLS

Removing rust from long steel scale by immersing it in a solution of ammonium citrate

BY USING a solution of ammonium citrate, rust may be completely removed from tools. If the solution is used warm, then one or two hours will suffice, but if used cold, it is best to allow the tools to remain in the liquid overnight. A tablespoonful of the ammonium citrate crystals may be used to a pint of water, although the proportions are not important. The solution will serve repeatedly until depleted.

For tools of awkward shape such as large steel squares, a cardboard mailing container may be used if it is first impregnated with hot paraffin wax.





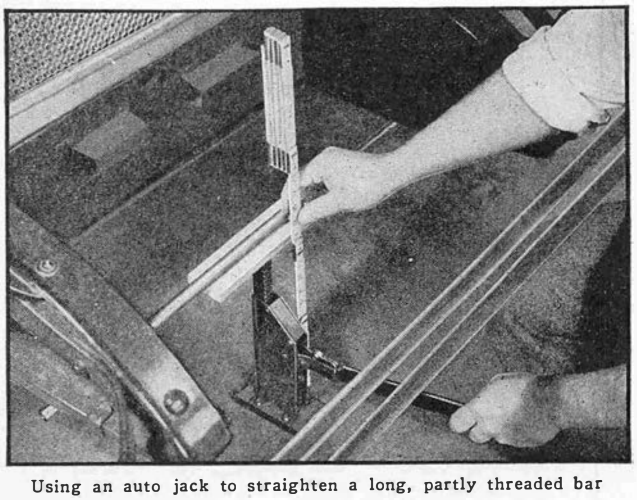
HOW TO STRAIGHTEN Long Turned Bars

Two easy ways in which the amateur machinist can remove the kinks that are likely to develop in slender turnings because of internal stresses

THE modern screw-cutting engine lathe is a tool of high precision designed to eliminate the uncertainty of human hands. In spite of that, one of the most delicate of the operations in turning a long, slender piece still remains essentially a hand job.

When you turn or cut a thread on a long bar of steel, the altered internal stresses in the material almost invariably pull it out of true. The only solution is a straightening job.

In firearms factories, the men who straighten barrels attain an almost unbelievable skill. The common method is to place the barrel across the jaws of a horizontally placed V-shaped piece of metal with the high point over the opening in the V. Then a heavy blow is struck on the high spot with a soft metal hammer. Experts, men who have been doing this work for years can take all the kinks out of a barrel with just a few properly placed blows of a hammer. But, as anyone can testify who has had experience in firearms factories, it's not as easy as it looks. You are more likely to put more kinks in than to take out those that are already existing.



Using an auto jack to straighten a long, partly threaded bar

The photograph below illustrates one of the safest ways to straighten bars in the home workshop. The idea, of course, is to hold both ends of the bar while you apply force at the kinked point with whatever means are available. In the case shown, the bar happened to be long enough to reach across from one front spring of the car to the other with a few inches to spare. The car's jack supplied the leverage to obtain sufficient pressure.

You will see that there is a small block of wood between the jack and the partly threaded rod. This is necessary to protect the thread and to spread the pressure over several inches of the rod.

Remember that brass, steel, iron, and most other metals have what is known as an elastic limit. You can bend them up to a certain point and they spring back to their original shape when the pressure is released, but if you bend even a trifle beyond that point the material takes a permanent set.

Suppose the bar you are turning develops a bend. The first job is to locate the high point of the bend as accurately as possible and mark the opposite side with a bit of chalk. Now set the bar ends against the supports so that the chalk mark is opposite the point where pressure is to be applied.

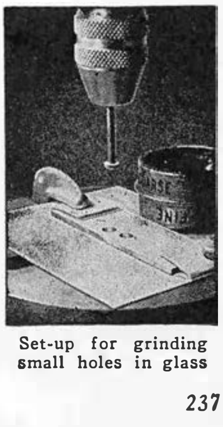
NOTE the reading of the rule to the sharp edge of the wooden block, and apply pressure. Bend the bar only a little, again read the rule, and release the pressure. Put the bar back between the lathe centers. If the kink is still there, repeat the process, this time applying a bit more pressure so the reading of the rule is a little greater. You will find, once you reach the elastic limit for the particular bar you happen to be straightening, that an increase in the bending of only 1/16 in. may be sufficient to complete the straightening.

The illustration at the left shows another way of applying pressure. In this case the fixed points are at one end and the high point of the kink at the center of the rod. Although this method looks as though it would require a lot of strength to bend the rod, it is much easier than it seems. By lifting with your shoulder muscles and at the same time swinging your body backward to lift the knee against which your lifting hand rests, you can exert an amazing amount of upward strain. Don't attempt to do this unless the lathe legs are firmly bolted.

ROUNDHEAD SCREW USED IN DRILLING GLASS

HAVE you ever tried drilling a hole in glass? The usual methods are discouraging, but the process illustrated eliminates breakage and provides very close control of the size and shape of the hole.

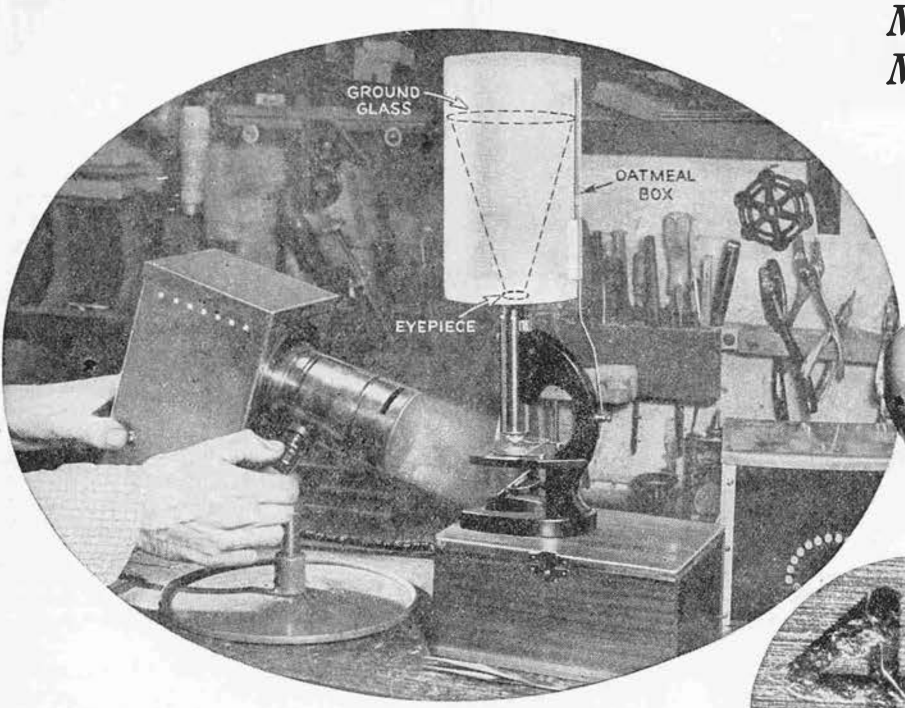
The necessary equipment includes a drill press, a steel roundhead machine or wood screw having the head diameter the same as the size of the required hole, and a little coarse valve-grinding compound. Place a very small quantity of the abrasive on the head of the screw; then bring the revolving head down onto the glass, being sure that the glass is held so it will not slip. The slot in the head of the screw helps hold the abrasive, and after running a little, the depression in the glass develops with a tiny point raised in its center, which aids in keeping the drill centered. Best results will be obtained if very little pressure is applied in feeding the drill.



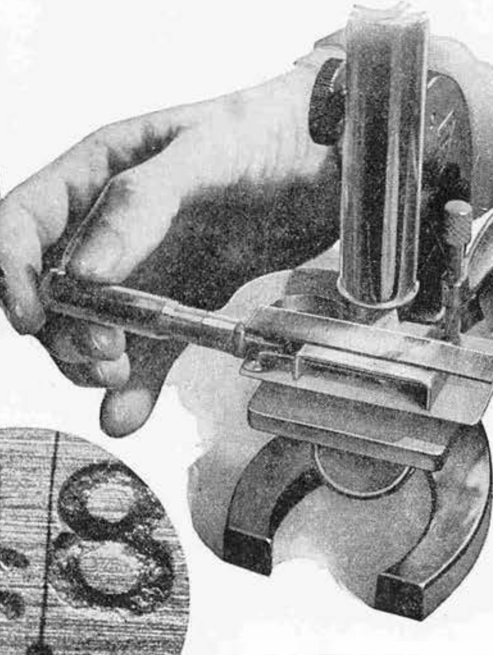
Set-up for grinding small holes in glass

Your MICROSCOPE as

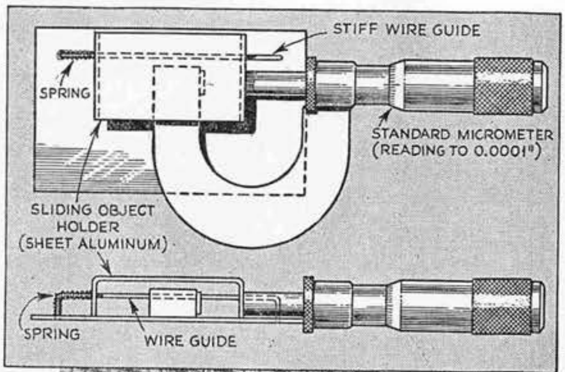
Magic Lenses Enable Many Tasks With More



With this simple microprojector set-up, the home craftsman can make examinations of screw threads, model parts, and other objects in the shop



Checking the accuracy of a steel rule with the homemade micrometer stage shown in the drawing below. Left, a division mark as magnified


STIFF WIRE GUIDE
SPRING
STANDARD MICROMETER (READING TO 0.0001")
SLIDING OBJECT HOLDER (SHEET ALUMINUM)
SPRING
WIRE GUIDE

PEOPLE who consider the microscope as a laboratory instrument used only by highly trained scientists and by amateur biologists, would be surprised to know the extent to which it is employed in the machine shop, at the factory bench, in the field, and in connection with the machine tools of countless industrial plants. Much of the present-day precision that is involved in the making of all manner of things, from bolts to battleships, is possible only because the microscope has become a shop tool.

The amateur microscopist frequently is also the owner of a home workshop; or he works in a garage, machine shop, or other place where the magnifying power of glass lenses might have a magic effect, and enable him to do better work than he possibly could turn out with the unaided eye.

A compound microscope of the type used by amateurs can be put to many uses in the workshop without altering it in any way. Magnifications generally required seldom exceed 100 diameters. The jobs such a microscope will do include the identifying of wood, examining of metal surfaces to see how well they are polished, identifying metals by their crystalline structure, examining minute cracks or fractures in metal, checking the cutting edges of tools, and examining paint and lacquer finishes on wood and metal.

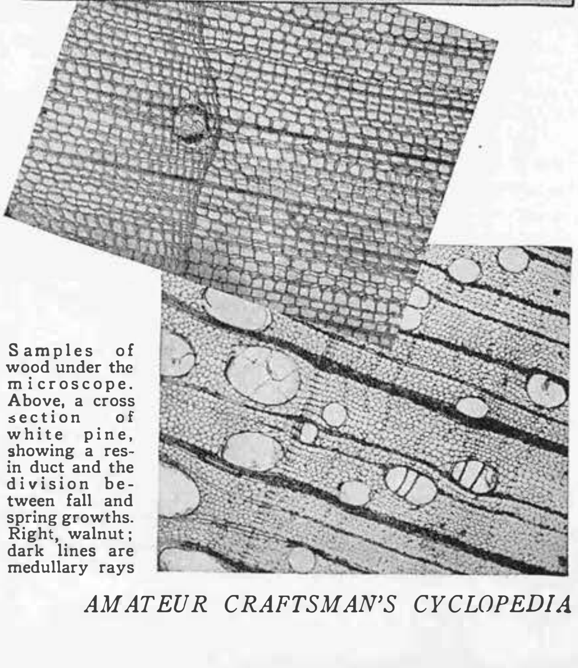
For most of this work you will need, in addition to the microscope, some glass slides, cover glasses, balsam, a sharp cutting tool such as a safety-razor blade equipped with a handle, and a source of illumination that can be adjusted for throwing light either on the substage mirror or on top of the object being examined.

The identification of wood is something that the craftsman who works in this material, particularly if he employs the rare imported woods, must be able to do. There is no more certain way of making such identifications than by means of a microscope.

In nearly all cases, an examination of the cross-section appearance of the wood will suffice. This shows the structure and arrangement of the cells making up the wood. Sometimes it is helpful to examine thin, longitudinal sections of wood, so that the sides of the cells instead of their cut ends are seen.

When you look at a thin cross section of wood, you see a series of curved layers formed by the annual growth of the tree, or, if the specimen is a small, woody stem, concentric rings.

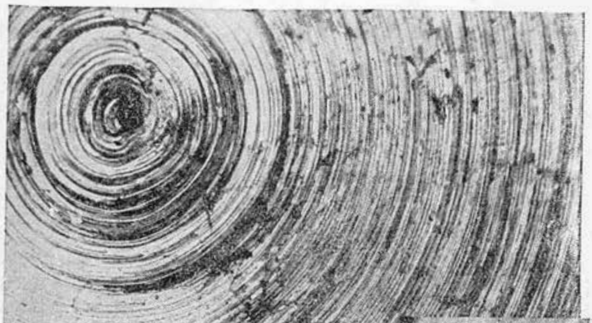
In addition, you will see radial lines of cells extending more or less perpendicularly to the rings. These are the medullary rays. Then there may be other distinguishing details, such as the resin ducts in white pine and the extremely large cells scat-

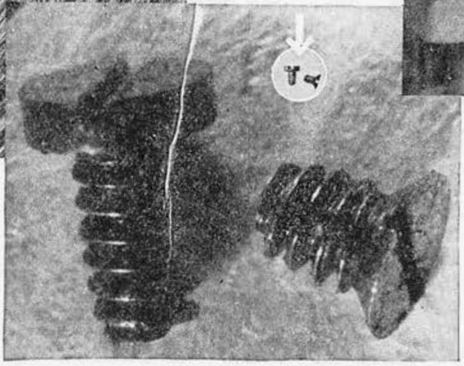


Samples of wood under the microscope. Above, a cross section of white pine, showing a resin duct and the division between fall and spring growths. Right, walnut; dark lines are medullary rays

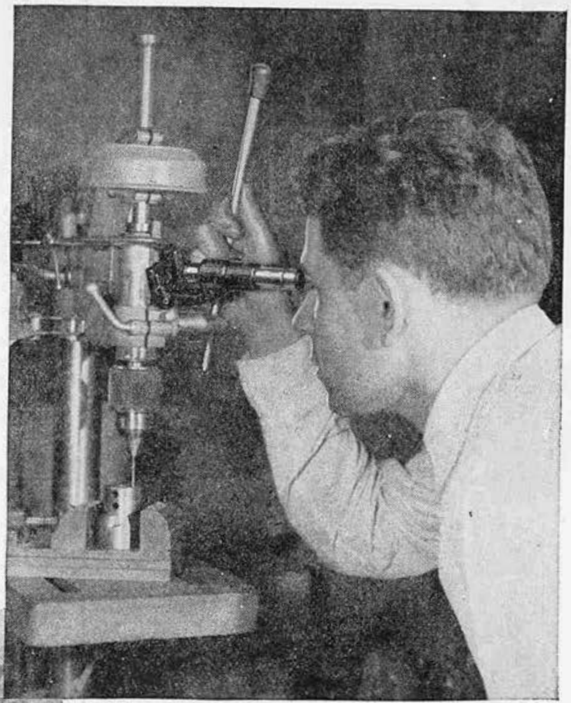
a Shop Tool

Home Craftsmen To Perform Ease and Greater Accuracy

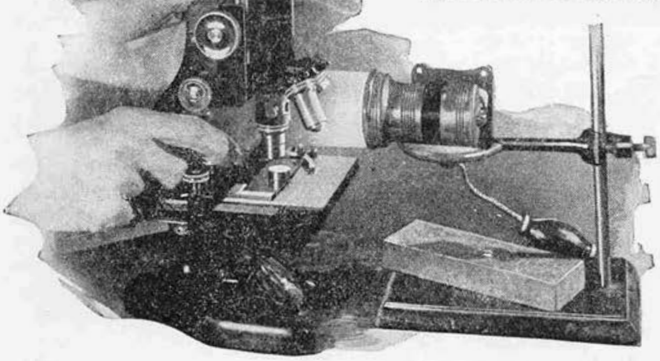




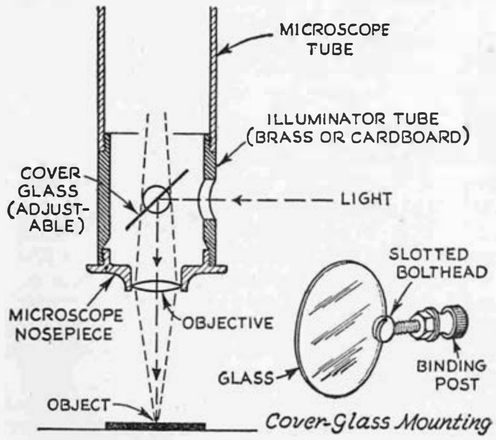
Lathe-tool marks on the end of a turned metal shaft, as seen through the microscope. Below are two tiny screws from a watch, (shown actual size in small circle) magnified for an examination of their threads. The larger of the two is 0.072 inches long



Using a small microscope in precision drilling. It is focused on a scale that moves with the drill bit



EXAMINING METAL WITH A MICROSCOPE
Surface markings on a brass button being inspected by means of a commercial vertical-illuminator attachment, to gauge the progress of a polishing job



HOW TO MAKE A VERTICAL ILLUMINATOR
If your microscope has an objective lens that can be unscrewed from the tube, you can rig up this vertical illuminator for examining various opaque objects

tered through walnut.

The arrangement of cells in a given specimen of wood produces a pattern that is characteristic of that wood. Thus, if you are familiar with the appearance of a piece of walnut under the microscope, you always can tell with certainty whether a sample of wood is walnut or not.

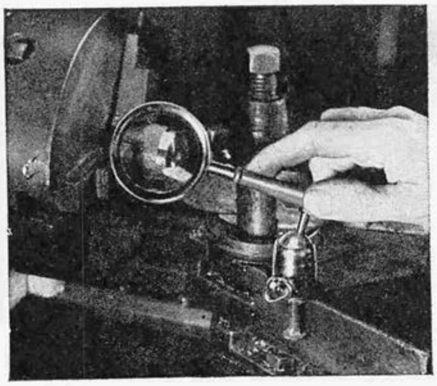
You can easily collect samples of various kinds of cabinet woods, incuding such well-known varieties as walnut, mahogany, and maple, as well as a great many of the rarer woods. From such samples you can make microscope slides which, when properly labeled and filed away, form a reliable reference "library" that can be used for identifying unknown woods at any time in the future.

The making of such a reference slide is a simple operation. Select a small block of seasoned wood that has not been stained, painted, or otherwise treated, and slice a number of very thin pieces from one end. A keen-edged razor blade can be used; and you can make satisfactory slices free-hand. Examine several of the tiny chips, and select the ones that show the grain structure most plainly. Try to include sections of three or four annual rings in each piece that you select for mounting.

As the wood already is dried, you can mount the slices immediately. To do this, drop a little Canada balsam in the middle of a clean glass side, dip the wood specimen in xylol, and with tweezers lay it on top of the drop of balsam. Gently press the wood down into the balsam, until it is covered completely. The object is to immerse the wood without trapping air in its cells. Finally, lay the cover glass over the balsam, and set the slide aside to dry. Of course, if you desire, you can stain the wood with methylene blue or other dye, but most woods can be mounted without staining. Examine wood specimens by transmitted light, at magnifications of twenty to 100 diameters.

Frequently, the craftsman who is working with metal desires to know how well a polishing or grinding operation is being carried out. His unaided eyes may tell him; and again they may leave much room for doubt. But with a small microscope, he need never be uncertain. At fifty to 100 diameters, the surface marks on a piece of metal stand out like furrows in a plowed field. What appears to the unaided eye as a brilliant polish will be seen as a colection of irregular grooves and ridges. By comparing the depth and size of these markings, the degree of polish can be determined. In a similar way, bearing surfaces can be inspected, and bits of embedded metal or pits caused by corrosion can be seen. Metal objects can be examined for indications of rusting or other corrosion, and a hundred and one other useful observations can be made.

Since metal is opaque to light rays, it must be illuminated from above. Professional microscopes are equipped with vertical illuminators which send light rays down through the objective lens, to be reflected through the same lens by the metal surface. Although you can construct an effective vertical illuminator by mounting a cover glass or bit of mirror between the objective and eyepiece and arranging



A hand magnifying lens attached to a lathe carriage with a ball-and-socket tripod joint

a hole in the side of the mounting for light to enter, most shop inspections can be made with light coming at an angle, from a source above and to one side of the stage. A small automobile spotlight operated by a suitable transformer or battery makes a satisfactory illuminator. It is placed so that the brightest spot is focused on the metal specimen, at a point directly below the objective.

ONE of the drawings shows the construction of a vertical illuminator for use with a microscope that has an objective lens that can be unscrewed from the microscope tube.

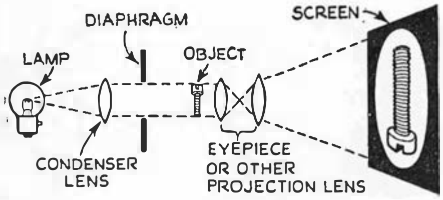
Metals resemble woods in that they have characteristic structures. These crystalline structures are used in metallurgical laboratories for identifying unknown alloys, for determining the effect of heat treatments, and for learning other inner secrets of metals. Although the home craftsman usually does not find it necessary to go into the crystalline structure of alloy steels and other metals, the amateur microscopist who is also a metal worker may find it interesting to know how specimens are prepared for microscopic examination.

First, it is necessary to give the metal to be examined a very high polish. This can be done by grinding the specimen flat with a fine-grained wheel, honing it on first a rough and then a fine-grained razor hone, polishing it with successively fine grades of abrasive powder, and ending up with optical rouge or some other polishing agent that produces scratches smaller in diameter than the length of a light wave. Polishing powders are held in "laps" made by tacking pieces of cloth to blocks of wood, moistening the cloth with water, and sprinkling it with the brasive powder. A different lap is used for each grade.

AFTER a polish is produced, which reveals no deep or wide grooves when examined by the microscope, the metal is ready for etching. There are a great many etching agents in use. These include a mixture of ammonia water and hydrogen peroxide, for brass; a five-percent solution of silver nitrate in water, for lead-tin alloys; a two-percent solution of nitric acid, for cast iron; concentrated nitric acid and ammonium persulphate, for steel; picric acid in methanol, for steel; equal parts of hydrochloric acid and water, for revealing fractures in steel; and various concentrations of nitric acid in water, for steel.

After the etching solution has acted, wash the specimen in water, and, if an iron alloy, dry it as rapidly as possible, in order to avoid oxidation. Examine it with the aid of a vertical illuminator, if you have one. Otherwise, arrange the light so that it strikes the specimen as nearly as possible at right angles. Minute fractures in steel, copper, and various other metals can be examined with the microscope at moderate powers. Usually, such tiny cracks in steel can be revealed by etching for ten to twenty minutes in a half-and-half solution of hydrochloric acid and water.

The edges of such tools as lathe bits, carving chisels, metal engraving tools, tiny drills, razor blades, and a host of other cutting instruments can be examined easily with the aid of a microscope. Usually, a magnification of ten to fifty diameters is adequate. The tools can be illuminated by light coming from behind them, so that their edges are seen in silhouette; or they can be illuminated from above or at an angle, so that surface details near the cutting edge are seen. It is best to use both methods when possible.



Your microscope can be used as a projector by setting the object in the position shown here

IN the laboratories of automobile manufacturers and other concerns using cellulose lacquers or paints, microscopic examinations are made to determine the wear and weathering properties of the finishing materials, and to check their uniformity. Examination of a painted surface after it has been in use for a time may reveal surprising facts about its condition. It might look perfectly smooth and intact to the eye, yet be shown by the microscope to be broken up by a network of fine cracks that render it worthless as a protective covering.

Another important industrial use for microscopes is in making precision measurements. Professional-type microscopes like those found in a well-equipped biology laboratory can be provided with special micrometer eyepieces with which accurate measurements of diameters and lengths can be made.

The amateur microscope can be converted into a crude but effective measuring device for small objects by mounting on its stage a machinist's micrometer in such a way that turning the micrometer screw moves the object laterally. One possible way of doing this is illustrated. The object is supported by a platform of sheet metal that moves sidewise against the action of the micrometer. The amount of movement is read on the micrometer scale.

It is necessary to equip the microscope eyepiece with a marker that is set at the point on the object from which measurement is to be made. This marker can be a bristle from a camel's-hair brush, cemented with a drop of balsam at a point in the eyepiece where a sharp image of it will be seen; or it can be a strand of spider web. This point usually is in the plane of the diaphragm in the eyepiece.

Suppose you are going to measure the distance between two holes in a piece of metal. Lay the piece cn the movable stage platform and move it until the center of one hole is directly beneath the cross hair in the eyepiece. Note the micrometer reading. Then turn the micrometer screw to move the object until the other hole is beneath the hair. Make another reading. The difference between it and the first indicates the distance between the holes, in thousandths or ten-thousandths of an inch.

RECENTLY there has appeared on the market a micrometer, made of cast metal, that retails for twenty-five cents or less. It can be converted into a stage measuring device of fair accuracy, although not as durable or of as great range as a larger and more costly instrument such as machinists use.

A microscope with a cross-hair eyepiece can be used as a super-eye for reading scales divided into small fractions of an inch or millimeter. Magnifications of moderate degree, say ten to twenty diameters, are employed. The field should be large enough to enable differences in engraved lines to be seen. The microscope is mounted so that it can be focused on a scale that is attached to the movable part of a machine, or the scale can be fixed and the microscope movable. Thus the microscope might be fastened to a lathe bed and focused on a scale attached to a chuck mounted on the tailstock spindle, to measure the depth of a hole being bored in work held on the faceplate; or the microscope could be mounted on a drill press and focused on a scale attached to the spindle housing, for precision drilling. Another application is to mount the microscope on a lathe carriage and focus it on a scale fastened to the tailstock or other stationary part, for precision turning when there is no calibrated carriage feed on the lathe.

Even the microprojector has invaded the workshop. In hundreds of industrial plants, such instruments are used to check the contours of gear teeth and screw threads, measure the size and shape of small machine parts, and are being used daily to do a thousand and one other things.

Such instruments, called contour projectors, consist of a microscope or projection lens, a source of illumination, a screen, and an object holder. The object to be projected can be mounted between the lamp and the microscope lens, just as a standard slide is placed. A shadow image of it is thrown on the screen, where a chart can be placed to indicate how well the object conforms to standard specifications.

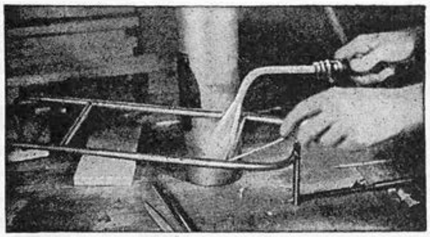
A SIMPLE vertical illuminator is provided for use with such instruments for throwing light vertically on the surface of polished gears or other metal parts. This illuminator consists of a sheet of clear glass placed at an angle of forty-five degrees to the surface of the object, and a light source mounted so that it projects a beam against the glass, which in turn reflects it to the object.

The amateur microscopist can rig up a useful microprojector for throwing images of screw threads, gears, tool edges, saw teeth, and other small objects on a screen where they can be inspected in magnified form. The model maker will find such a device useful for producing miniature parts that are exact scale models of larger parts. The part is drawn, in enlarged form, on a sheet of paper, and used as a pattern to check the shape of a smaller model of the part, whose image is projected on the drawing.

The projector can take a variety of forms. A simple arrangement is to mount a light source, preferably a concentrated-filament lamp such as an automobile headlamp operated by a toy transformer, in such a way that its beam illuminates an object placed on the microscope stage. The lowest power of the microscope usually is sufficient. The beam can be directed against a ground-glass screen supported above the eyepiece, against a sheet of white paper, or against a mirror which reflects it on a sheet of white cardboard or paper.

WATCH ADJUSTED ACCURATELY WITH AID OF MICROMETER

A WATCH may be adjusted with great accuracy if machinists' micrometer calipers are available. After removing the back from the watch, place the micrometer in such a position that when it is adjusted to close, it moves the regulating lever to fast or slow (whichever is desired). This method will not damage the micrometer in any way. If the watch is checked with radio time signals, it can be adjusted very accurately.

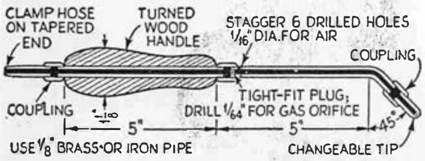


HANDY ACETYLENE TORCH FOR HOME WORKSHOP

ACETYLENE has many uses in the home workshop and is not costly if a simple torch, similar to the one illustrated, is constructed. The outfit will do brazing, soldering, annealing, sweating, and many other operations which require heat. It is not a welding outfit as pure oxygen is not used, the air being sucked in by using the principle of a Bunsen burner.

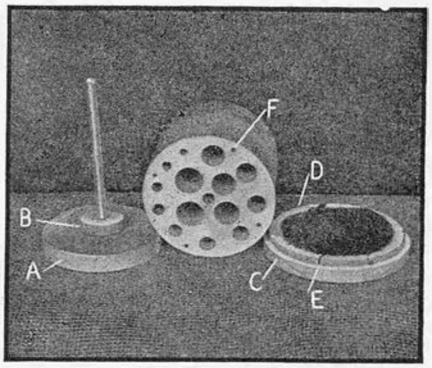
The complete apparatus consists of the smallest size acetylene tank, 6 ft. of ¼-in. hose, and the torch. You can pick up the tank in a junk yard for a dollar or so, and the hose costs only about nine cents a foot.

Refills for the tank cost about a dollar. A commercial torch costs several dollars, but the one illustrated was made for a dollar. The torch's tip may be made smaller by first heating it, or the end may be plugged and then drilled to suit your needs. A coupling at each end of the handle keeps it in place. Six 1/16-in. holes are drilled in the ⅛-in. pipe to admit the air.

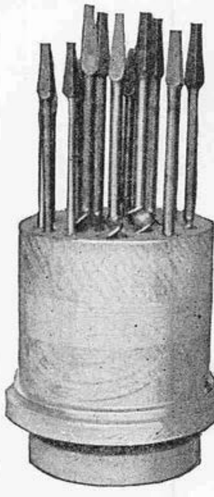

CLAMP HOSE ON TAPERED END
TURNED WOOD HANDLE
STAGGER 6 DRILLED HOLES 1/16" DIA. FOR AIR
COUPLING
COUPLING
TIGHT-FIT PLUG; DRILL 1/64" FOR GAS ORIFICE
5"
5"
45°
USE 1/8" BRASS OR IRON PIPE
CHANGEABLE TIP

This acetylene torch is not a welding outfit, but follows the Bunsen-burner principle

OILED RACK PROTECTS BITS FROM RUST



The parts of the holder. The bits rest on an oiled felt disk which fits within ring *D*



The revolving rack and an assortment of bits

AUGER bits can be kept free from rust and protected from accidental damage by making a revolving rack like the one illustrated to hold them.

Glue up a block of wood 5½ in. square and 4 in. thick, mark a 5-in. circle, and band-saw closely to the line. (If a band saw is not available, the rack may be left square and the revolving feature omitted.) Make base *A* ¾ in. thick and 4½ in. in diameter. Part *B*, which serves as a washer, is ½ in. thick and 1¾ in. in diameter. Bore a ⅜-in. hole in the center of each and fit and glue a ⅜-in. dowel 7 in. long in them, being sure the dowel stands vertically. Make a disk *C* ½ in. thick and 6 in. in diameter, and another disk *D* ¼ in. thick and 5⅜ in. in diameter. Then cut out the inside of *D*, so as to leave a ring of wood ⅝ in. wide. This can be done by entering the band saw at any point as indicated at *E*. Then glue and brad *D* to *C* as shown and bore a 7/16-in. hole in the center of *C*.

Find the center of the top and bottom of the rack, and make a pasteboard pattern to show where the hole for each bit should be bored. One accurate way to do this is to cut a disk of paper the size of each bit, place each to best advantage on the cardboard, and mark each center with a prick point. Use this to mark the center on the top and bottom of the block so that corresponding pairs will match exactly. Bore each hole 1/16 in. larger than the bit it is to hold, and also bore a 7/16-in. hole in the center. In all cases bore partly through from one side; then bore from the other until the bit clears itself in the hole first bored.

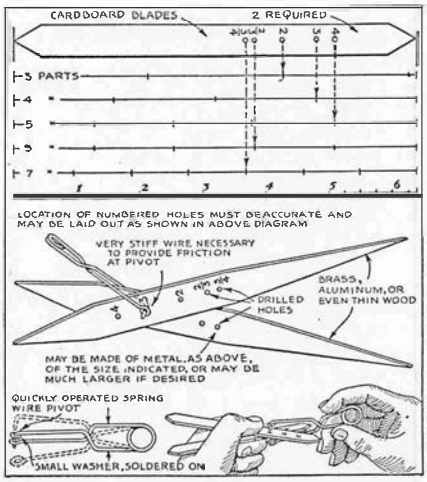
Fit a piece of felt in ring *D*, make a ½-in. hole in the center of the felt, and bore four holes through *C* and *D* and corresponding holes in the rack as at *F* so that *C* and *D* can be fastened to the rack with 1½-in. No. 10 screws. Then drop the rack over the dowel. If a drop or two of oil is put in each hole occasionally, the bits will remain bright and in good condition.

• • •

MAKING PROPORTIONAL DIVIDERS

IF ONE'S drafting kit does not include proportional dividers, an efficient substitute for this rather expensive instrument may be easily made by the method illustrated. The dividers will be found very useful for enlarging or reducing a drawing or sketch.

The blades may be made of cardboard, brass, aluminum, or even thin wood. If of cardboard, cut the two blades to the shape shown in the upper diagram; if of stronger material, taper them as suggested in the larger perspective drawing. Then mark the blades as accurately as possible for the holes. The principle of laying these out is made clear by the divisions on the five lines drawn immediately below the pattern for the cardboard blades.


CARDBOARD BLADES
2 REQUIRED
2
3
4
3 PARTS
4
5
6
7
1
2
3
4
5
6
LOCATION OF NUMBERED HOLES MUST BE ACCURATE AND MAY BE LAID OUT AS SHOWN IN ABOVE DIAGRAM
VERY STIFF WIRE NECESSARY TO PROVIDE FRICTION AT PIVOT
DRILLED HOLES
BRASS, ALUMINUM, OR EVEN THIN WOOD
MAY BE MADE OF METAL, AS ABOVE, OF THE SIZE INDICATED, OR MAY BE MUCH LARGER IF DESIRED
QUICKLY OPERATED SPRING WIRE PIVOT
SMALL WASHER, SOLDERED ON

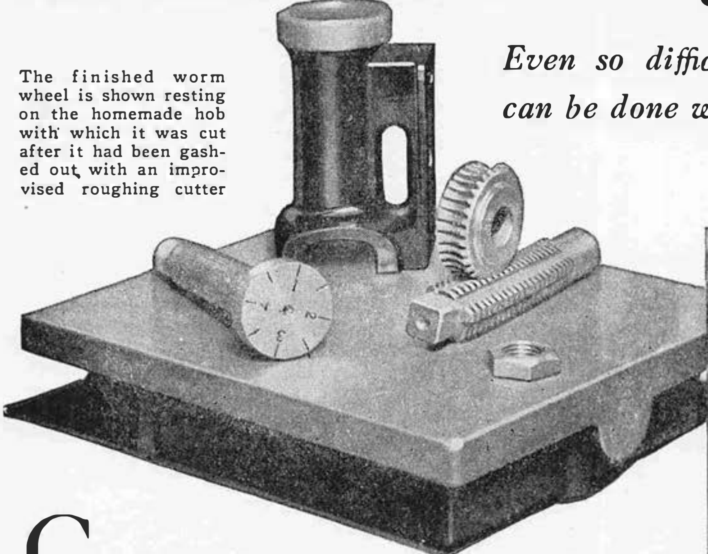
How to lay out blades for proportional dividers, and a quick acting spring wire pivot

If, for example, it is desired to enlarge a drawing to exactly twice its size, the blades should be divided lengthwise into three parts and the hole made at one of the divisions so that, when the instrument is assembled, the distance from the pivoted joint to the one end will be exactly twice the distance from the joint to the other end. Similarly, to enlarge three times, the blades must be divided into four parts and the pivot hole placed at a point one quarter the length of the blades from one end. Other divisions can be worked out in the same way. For small work, a good length to make the blades is 6⅜ in., as indicated by the inch scale placed beneath the lines upon which the divisions have been marked.

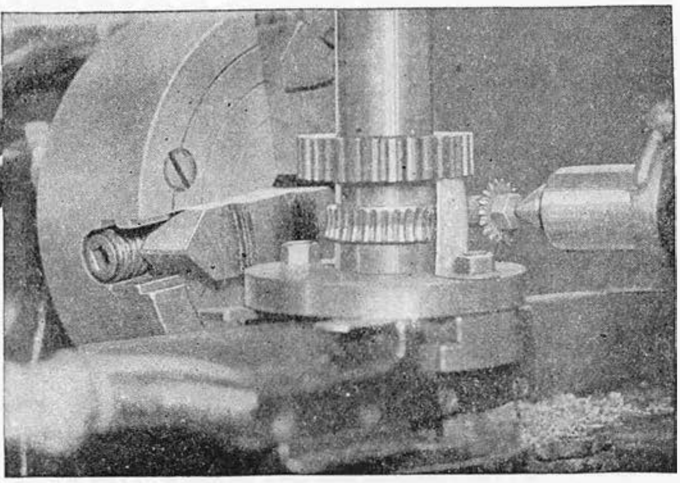
The pivot should be quickly removable for setting the blades. The wire design shown has given satisfaction and is not difficult to make.

Gear Cutting *in the* Lathe

Even so difficult a job as hobbing a worm wheel can be done with limited home-workshop equipment



The finished worm wheel is shown resting on the homemade hob with which it was cut after it had been gashed out with an improvised roughing cutter



The set-up for the roughing operation. One of the regular lathe change gears was mounted on the blank for indexing

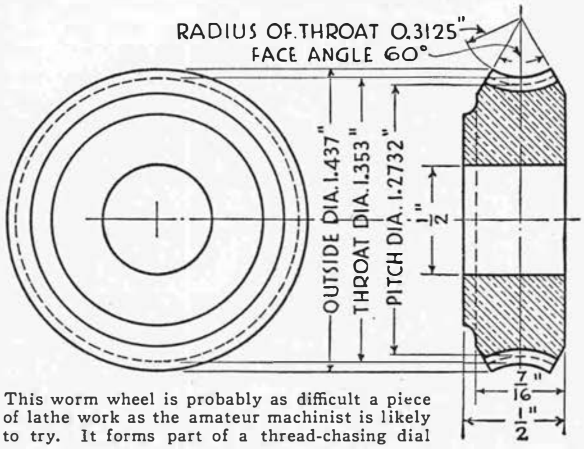
CUTTING a worm wheel by the hobbing process is rarely considered a job for the small engine lathe, but in the amateur's home workshop, as in many other similar shops, such a machine is the only tool equipment. In this case the gear was needed to drive the homemade thread-chasing dial that is illustrated in the photograph above.

Special tools required were an improvised work arbor for mounting the gear blank, a gashing or stocking cutter to rough out the teeth, and a hob for finishing.

The hob photographed with the finished gear was turned from tool steel and threaded to correspond exactly to the lead screw of the lathe. This screw is ¾ in. in diameter, Acme form thread, 8 threads per inch. The squared shank and tapered end of the hob are not necessary features and were added only to make the tool usable later as a tap. A hexagon nut was soft-soldered on the tapered end and by this means the hob, while mounted on improvised centers, was indexed and wedged into position for cutting the flutes, which make of it a milling cutter. A 7/16-in. end mill mounted in the lathe spindle was used for this purpose. After fluting, the teeth were carefully burred and backed off with a file, and then the hob was hardened.

The roughing cutter was ground freehand from one of the hard-toothed disks used in dressing emery wheels. The cutter, which had been worn out in this service, was ground to ¾ in. in diameter, the teeth gashed deeper on a flexible wheel, and then ground to approximate form. This rough-and-ready milling cutter was then strung onto a ¼ by 3 in. cap screw with a section of ⅛-in. pipe for a sleeve and the screw head centerdrilled for the tailstock center.

A work arbor, required to mount the gear blank for cutting, was turned from a piece of 1¼-in. shaft, shouldered down to slip freely through the bore of the gear, and threaded into a plate fitted to the lathe compound.



This worm wheel is probably as difficult a piece of lathe work as the amateur machinist is likely to try. It forms part of a thread-chasing dial

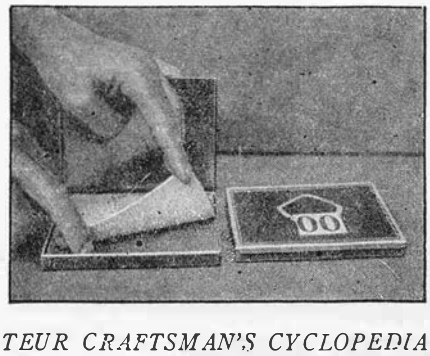
The gear blank was turned from a section of bronze rod and bored. Its throat diameter, the one critical dimension, was fixed by the desired number of teeth (32), and details of the lathe lead screw, that is, a single Acme screw ¾ in. in diameter and with a ⅛-in. lead or linear pitch. The dimensions given in the drawing were computed from a formula in a standard handbook on spiral and worm gearing.

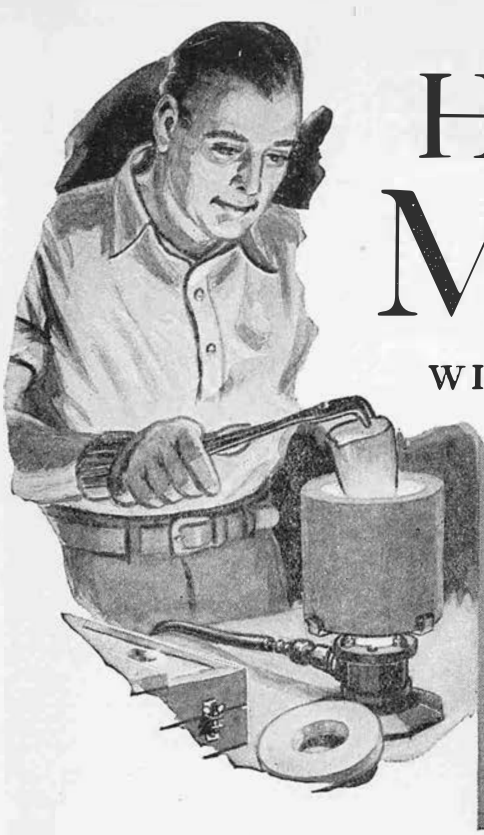
The set-up for the roughing operation is shown directly above. For purposes of indexing the blank, one of the lathe change gears (32 teeth) was doweled to the blank and mounted just above it on the work arbor. A sheet-metal finger arranged to engage its teeth served to indicate positions, which were fixed after indexing by screwing the arbor down into the base plate. It will be noted that this plate is shimmed high on the chuck side, which inclines the arbor and blank to a degree corresponding to the thread angle of the screw. With this arrangement the gear was roughed out by sinking the cutter each time to the limit set by the cross-slide stop.

For the final hobbing operation, the roughed-out gear was allowed to turn freely on the arbor by drawing out the dowel pin, and then the arbor was brought into a vertical position. The hob, mounted on lathe centers, was now set in motion and the work fed into it, deriving motion from the generating hob. When sunk to the proper depth, as proved by the hob's just bottoming or "cleaning up" on the throat diameter of the worm wheel, the job was done.

CIGARETTE TINS HOLD SANDPAPER SQUARES

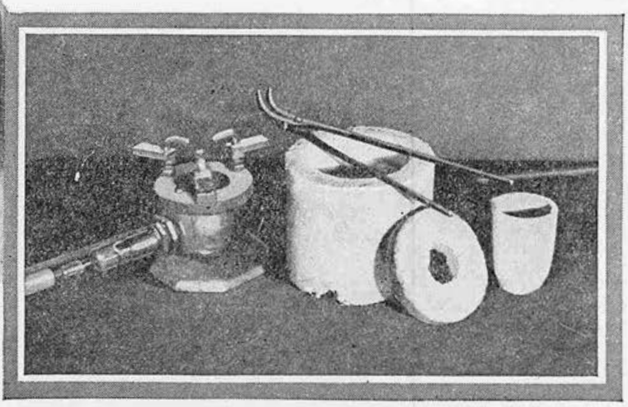
SANDPAPER squares are usually kept in an exposed, dusty, unassorted pile in the average home shop. It is much better and more economical to store them in flat tin cigarette boxes of the type shown. These are exactly right for sandpaper and keep it straight, clean, and dry. Numerals can be cut from old calendar sheets and glued to the covers to indicate the grade of paper in each box.



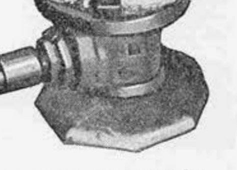


Homemade Furnace Melts Aluminum

WITH ORDINARY ILLUMINATING GAS

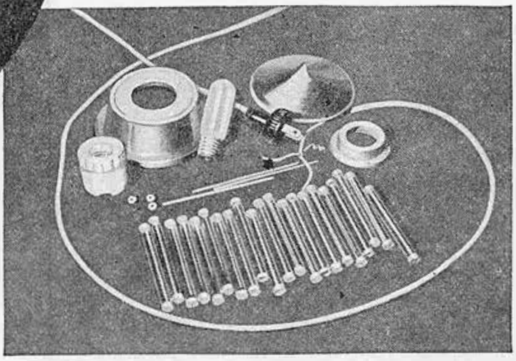


The burner, asbestos baffle, crucible, and cover are shown at the left. The body of the burner is an old 2 by 1¼ by 1¼ in. pipe tee. The gas and air enter through the side outlet



The mixture of gas and air is adjusted by means of a sliding sleeve on the inlet pipe

Castings for models and for such attractive novelties as this lamp are made with the aid of the furnace

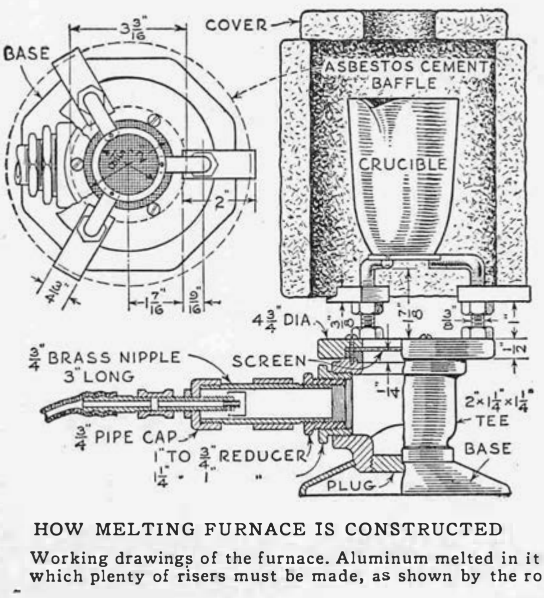


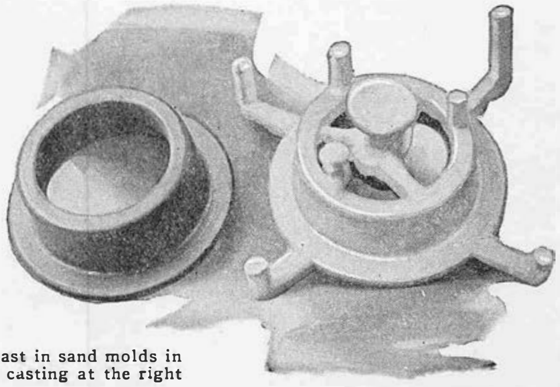
The lamp ready for assembly. This project is a good example of what can be done with homemade castings

FURNACES for melting brass are often constructed by amateur mechanics with a vacuum-cleaner blower for the forced draft. However, aluminum can be melted without a forced draft, and as aluminum will answer the purpose in most cases where castings are required by the amateur mechanic, this method will appeal to many who have hesitated to attempt making their own castings. The average amateur with a small lathe will find working with aluminum every bit as easy as brass.

Brass requires 1,8000 deg. F. to melt, while aluminum only requires 1,200 deg. The burner shown in the photographs melts aluminum with ordinary illuminating gas. It was made from an old 2 by 1¼ by 1¼ in. pipe tee. A pipe plug was screwed securely into the bottom and machined off. Then a shoulder was cut on the outside of that end of the tee and fitted into an opening in an old lamp base, which had been machined to match. The edge was peened over to hold it in place.

Reducing bushings were used in the side outlet to reduce it to ¾ in., and a piece of ¾-in. brass pipe, about 3 in. long, was screwed in. This piece of pipe had two openings, each about ¾ in. square, one on each side, about 1 in. from the outer end.





HOW MELTING FURNACE IS CONSTRUCTED

Working drawings of the furnace. Aluminum melted in it is cast in sand molds in which plenty of risers must be made, as shown by the rough casting at the right

A sleeve was made to slide over these openings to control the mixture of air and gas. A pipe cap, drilled and tapped for ⅛-in. pipe, was then screwed on the outer end of the pipe.

A PIECE of brass rod about 3 in. long was then threaded with a ⅛-in. pipe thread on the outside for about 1½ in. of its length. The outside of the other end was corrugated for the gas hose connection. This piece was drilled out ⅛ in. in diameter, and the threaded end was bushed down to 1/16 in. to reduce the flow of gas. The piece was then screwed into the pipe cap and held in place with a lock nut. The long running thread on this part is for the purpose of adjusting it to get the best flame in the burner.

The top of the tee was faced off and the thread bored out. A piece of cast iron was machined with a shoulder to fit over this, to hold a piece of screen and also to receive the legs that hold the crucible and baffle. This ring was fastened to the tee with three ¼-in. roundhead machine screws. The screen is ordinary mosquito netting, doubled.

The legs are made of ⅜-in. cold-rolled steel, heated and bent, and the lower part threaded full length with a ⅜-in. machine thread. This running thread is so that the legs can be adjusted to get the crucible in the hottest part of the flame and also so the lugs that hold the baffle can be adjusted to the right height. The legs are locked in position with lock nuts, and the lugs are also locked with lock nuts.

The baffle is made of asbestos cement. This was constructed by first bending a tin cylinder about 1 in. larger than the desired diameter and using an old 2-qt. fruit jar for a core. After the wet cement had been pounded into place, the glass jar was drawn out, and the baffle was set on top of the coal furnace in the cellar to harden. It shrunk about 1 in. in diameter while drying. The cover was made of the same material. This has a hole in the center, about 2 in. in diameter, to allow the hot burnt gas to pass out.

Any ordinary crucible, about 2½ in. in diameter by 4 or 5 in. high, can be used. Such a crucible is obtainable from chemical-apparatus supply houses, or from dealers in supplies for art-metal work.

OLD aluminum crankcases or flywheel cases can be obtained from any automobile junk dealer and cut up into pieces.

The mold is made in sand in the usual way, but plenty of risers should be provided for in the mold (as shown in one of the photos) to allow the gas to escape. If this is not done, the metal will not run properly. It takes about fifteen minutes for each heat. The mold can be made while the metal is melting.

The lamp illustrated is an example of what can be done with castings made in this way. Three stainless steel rods, threaded at each end, are screwed into the top and fastened to the base with three nuts. The twenty-one glass tubes are from a dentist's anesthetic needle and had been discarded. They have rubber ends that serve as gaskets. What can be described as a "one-stepped" washer holds the porcelain socket. An intermediate base lamp, together with a cord and plug, completes the assembly.

HOW TO USE WIRE-DRAWING PLATES

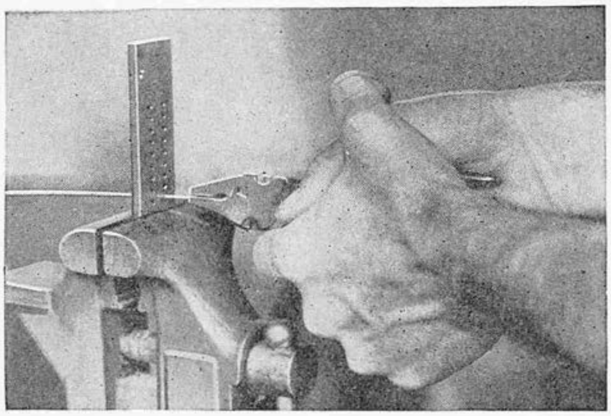
FEW mechanics, amateur or otherwise, know much about wire-drawing plates, yet these tools are most useful, and once tried, are hard to get along without. They are particularly useful to model makers and in the long run save considerable time and money.

The plates are made in several styles. With them wires of copper and similar soft metals, and even mild steel, can be made round, square, knife-edged, or half-round. With two plates in the round variety, it is easy to reduce ⅛-in. wire to 1/64 in. with almost no loss of material and an increase of length of almost 6,400 percent. The plates are obtainable at jewelers' supply houses and cost only about $1.50 each.

The operation is this: Clamp a plate upright in a vise, name-face to the front. Sharpen one end of the wire to be drawn, making a long point. Insert the point in a hole small enough to bind, grasp it with pliers, and pull it through, using a smooth, steady force. Repeat with the next smaller hole, and so on. After being reduced in several holes, the wire will need to be annealed by heating it to redness.

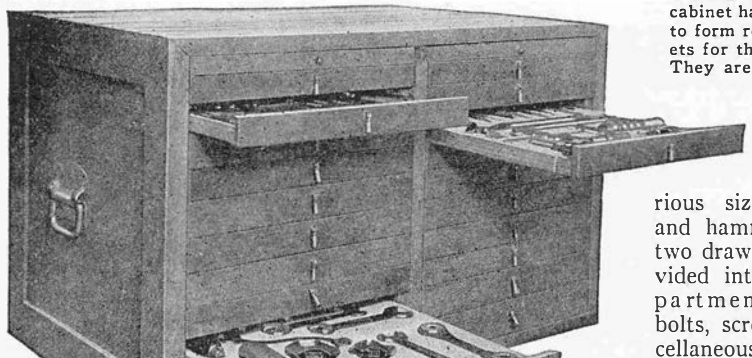
The drawing, it will be noticed, not only reduces the diameter, but straightens the wire so that there are no local kinks whatever. This in itself is an advantage in most kinds of work. Besides, the exact degree of hardness and stiffness can be obtained to suit the requirements of the work in hand. The principal advantage, however, is that the owner of such plates needs to stock but one or two sizes of the metals he commonly uses as he can quickly make any smaller size necessary.

The usefulness of the plates does not end with shaping, sizing, hardening, and straightening wire. They can be used for making tubing. Simply cut a strip of sheet metal of a width approximately 3 1/7 times the outside diameter of the tube required, snip a taper at one end, bend lengthwise into a shallow trough, and draw like wire to close the joint.



The wire is reduced in size by drawing it through successively smaller holes in the plate, which is clamped upright in a vise

CABINET HAS RECESS FOR EVERY TOOL



The drawers of this tool cabinet have been cut out to form recesses or pockets for the various tools. They are lined with felt

UNLESS every tool in your shop has its own place and is put back after you are through working with it, you are certain to waste much time. There are many good ways to rack your tools—wall panels, open shelves, and boxes—but cabinets are among the best because they give better protection to the tools.

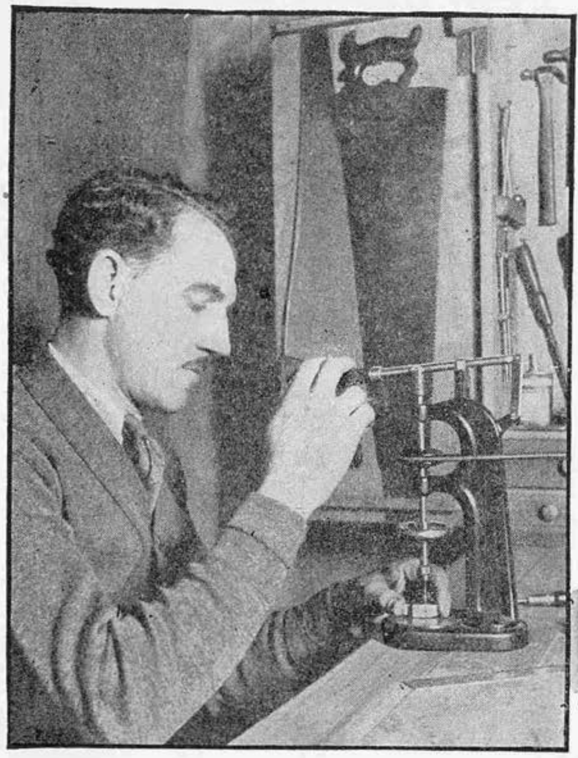
The size of the cabinet will naturally be made according to your own supply of tools or specific needs. It should be of strong lumber, and sufficient allowance made so that the drawers will slide easily. The cabinet illustrated is 24 by 28 in. with a double tier of drawers, 12 by 19 in. Each drawer contains its own type of tools, such as drills, chisels, screwdrivers of various sizes, wrenches, and hammers. One or two drawers can be divided into small compartments for nuts, bolts, screws, and miscellaneous hardware.

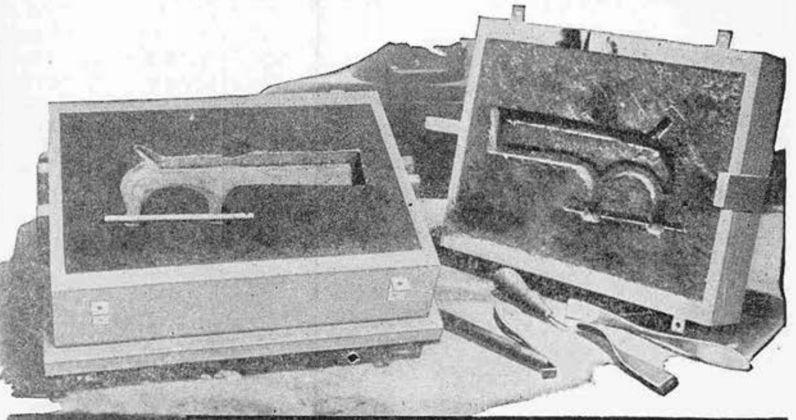
One method of forming pockets to receive the tools is to draw an outline around each tool with a flat-sided pencil on a board about 5/16 in. thick, which can be used as a false bottom in the drawer. A jig saw is used to cut out the pattern. Each opening should be smaller than the tool itself so that the tool will set in not quite halfway. The edges can be cut out on a slant or rounded off with a chisel if necessary, and a gouge may be used to cut any deep spots. A felt lining may then be glued in place.

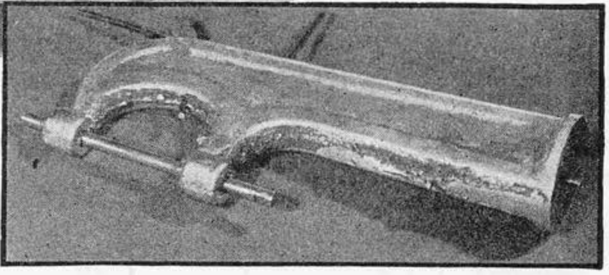
A better and more workmanlike cabinet drawer can be made by using a board ¾ in. thick for the bottom. After the outlines of the various tools have been drawn, a gouge is used to cut out the desired form so that each tool rests evenly in a perfectly fitting pocket.

Model Maker's DRILL PRESS

Built with Type-Metal Castings







The little drill press in use; the mold with pattern removed and steel rod in place as core for the bearings; and the rough casting

HOMEMADE castings of type metal give this drill press its neat and trim appearance. It can be made with a few simple tools, is smooth running, and will be found convenient for drilling those innumerable small holes needed in model work. The chuck and table are easily aligned, making it possible to produce accurate results.

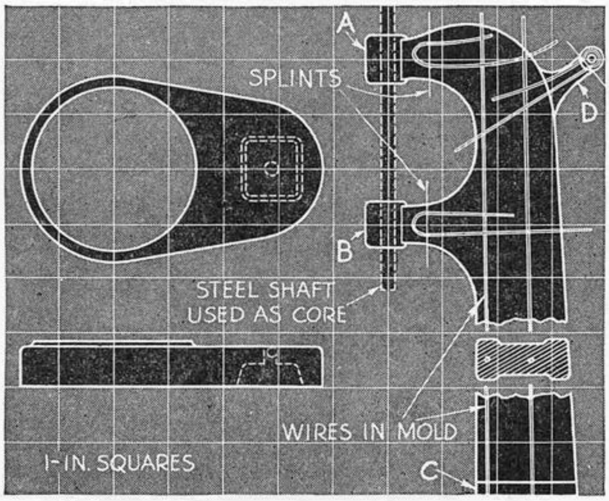
Any type metal will do, but the kind known as stereotype metal, used in casting type in the form of an entire page or part of a page, will give the best results. It is hard and tough, has a low melting point, and where the stresses are not great it serves the purpose as well as any other metal.

The total cost of the drill press in this particular case was only one dollar, which covered the purchase of a jeweler's pump drill, consisting of a chuck and spindle to which was attached a small brass balance wheel. The dimensions given, which are based on the size of this chuck and spindle, may have to be altered to fit the particular chuck and spindle used.

The spindle was originally 11 in. long, but was cut down to make the total length above the balance wheel 6 in. This balance wheel was left in place as it does not detract from the appearance of the drill press and does add materially to its smooth-running qualities.

The pattern used for the frame is made of ⅞-in. white pine; and the two bearings, shown at *A* and *B*, are sections of a ¾-in. dowel, glued and nailed in place. The pattern is planed down until the upper part and the two arms which hold the bearings are approximately ½ in. thick. Note that the sides of the pattern are recessed. This reduces the weight of the finished casting, but does not detract from its strength.

A disk of ¼-in. white pine 1⅞ in. in diameter is fastened at the foot of the pattern as shown at *C*. This gives a larger bearing surface where the drill frame rests on the base. The angle formed between the two pieces should be filled out with a plastic wood composition or putty so that the pattern can be more easily removed from the mold. The disk should be set at right angles to the center line of the bearings, for on this depends the accuracy and efficiency of the drill press.



The frame with reënforcing wire indicated, and the base plate

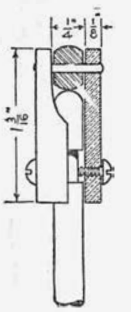
A short section of steel shafting of exactly the same diameter as the spindle is used as a core for the two bearings and left in the mold while the casting is being poured. The use of this rod as a core eliminates the necessity of drilling the holes and leaves the bearings smooth and in perfect alignment. The small arm *D*, used for holding the link between the frame and feed lever, is made with the pattern proper, although it could be a separate piece.

The pattern for the base is cut from one piece of ¾-in. white pine. The raised table is a thin disk of wood glued and nailed in place. A recess is cut in the bottom of the pattern to accommodate the head of the machine screw that holds the frame and base together.

Both patterns should be well sanded and given two coats of shellac to protect them from the moisture of the damp molding sand.

The method of re-enforcing the casting is indicated in the drawing of the frame. Clean the wires thoroughly and cover each with a thin coat of soldering flux. The ends of the wires that have a tendency to sag can be supported with slender splints of wood or broom straws, which will burn out as the hot metal enters the mold. The wires should be kept as near the center of the mold as possible. After removing the casting from the mold, the projecting ends are cut off and filed flush with the surface.

After the castings are smoothed up, and not before, the rod which was used as a core should be removed and the bearings ground out slightly with fine emery and oil. The two castings are assembled by means of a ¼-in. machine screw placed up through the recess in the base and forced into a hole in the frame.


The bearing at top of spindle

The cap or bearing at the upper end of the spindle is shown in the accompanying detail. This is cut from a ¼-in. (inside dimension) brass tube having ⅛-in. walls. Two holes are drilled and tapped for set screws which fit into the groove at the upper end of the spindle, allowing the feed lever to raise and lower the drill. In the absence of a tap of the proper size, the steel screws may be forced into the holes, the screws forming their own threads as they enter the brass. This method of tapping a hole may not be orthodox, but it works.

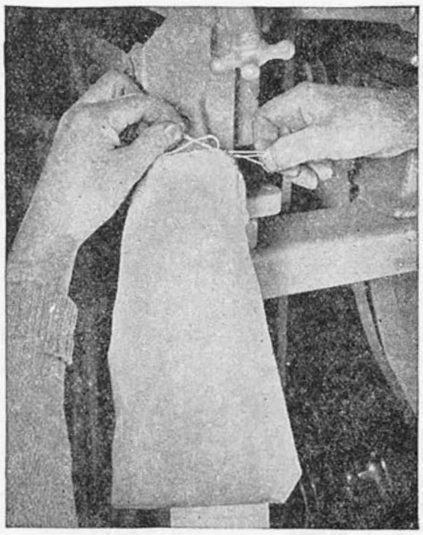
The link between *D* and the feed lever is made of two pieces of 3/32-in. iron bar, 5/16 in. wide and 2½ in. long, with ⅛-in. holes drilled at each end. The lever itself is a 5/16-in. rod fitted with a handle taken from an old wood-carving tool.

A coil spring to raise the drill point should be inserted between the feed lever and the frame. The lower end is held in a hole in the frame, and the upper end held in place with a clamp placed around the feed lever.

The drill is adjusted by inserting a wire in the chuck, the wire being bent to form a right angle just above the drill table. As the spindle is turned, any variation in the height of the outer end of the wire above the table should be corrected by inserting thin brass shims between the drill frame and the base.

MUSLIN MAILING SACK CATCHES SAWDUST

A CONVENIENT receiver for sawdust from a small circular saw is an ordinary heavy muslin mailing sack, which costs five cents and is equipped with draw strings. Merely slip the mouth over the sawdust chute and tie the strings in a bow.


To catch sawdust, a muslin mailing sack is tied over the chute of a small circular saw

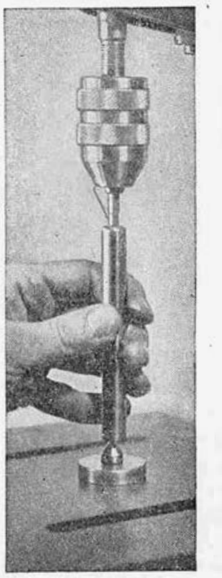
CENTERING ACCESSORY FOR DRILL PRESS

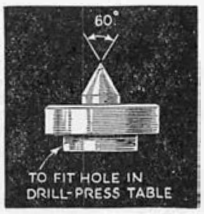
WITH this easily made accessory, many drilling, countersinking, and reaming operations that are usually done in the lathe may be performed quickly and accurately in the drill press.

The complete tool may be made in one piece from 1½-in. cold-rolled steel; or the body may be turned from cold-rolled steel, and the centering point turned from a piece of drill rod, hardened and tempered, and then inserted in a hole drilled in the body.

The body of the tool is placed in the hole in the drill-press table and the point is lined up with the drill. Both ends of the stock to be drilled are center punched, and drilling is done as when drilling between lathe centers.

With an arrangement like this, it is possible to drill holes from both ends of a rod and have them meet exactly in the center.





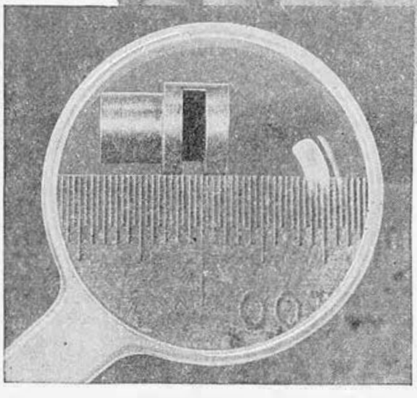
Measuring Split-Hundredths

WITH AN ORDINARY SCALE

DO YOU realize what can be done in the way of accurate measuring with an ordinary, high-grade steel scale? The hundredth of an inch divisions were not put on the scale as an ornament or to impress you with the quality of the tool. They are for use, and with a little patience and practice you can split the hundredths and make linear measurements correctly within a few thousandths of an inch.

Hair-splitting precision like this is easy. All you need is the scale, a small magnifying glass, a reasonable supply of patience, and above all, confidence in the fact that it can be done and that you can do it.

As an example, look at the two tiny slotted-head brass studs in the palm of the hand shown in the photograph above. The original pieces, of which these are copies, were located in such a position on the apparatus of which they are a part, that it was not possible to get at them even to measure the head diameter with an ordinary micrometer. All measurements were taken from the originals with the aid of nothing but a steel scale and a small magnifying glass.


Under a magnifying glass it is relatively easy to make measurements within .01 inch

Then a small brass rod was chucked in the lathe and two slots sawed in it sufficiently far apart to make the two pieces. A diamond pointed tool was then adjusted in the lathe tool holder at an angle so that the sides of the point cleared both the lengthwise and crosswise faces. Cuts were taken with great care, using the saw cuts as reference points, and the same scale and magnifying glass were used for the measurements.

On this job the critical dimension happened to be the distance from the upper edge of the saw cut to the shoulder on the stud. The second photograph shows one of the studs placed against the edge of the scale. This illustrates how coarse and easily read the hundredths of an inch divisions appear under a magnifying glass. It is clear, even from the photograph, that the dimension in question is a trifle over six and one half divisions and is, therefore, approximately .066 in., the required size. A check-up after the studs were finished showed one of them calibrated .0668 in., the other .0672 in.

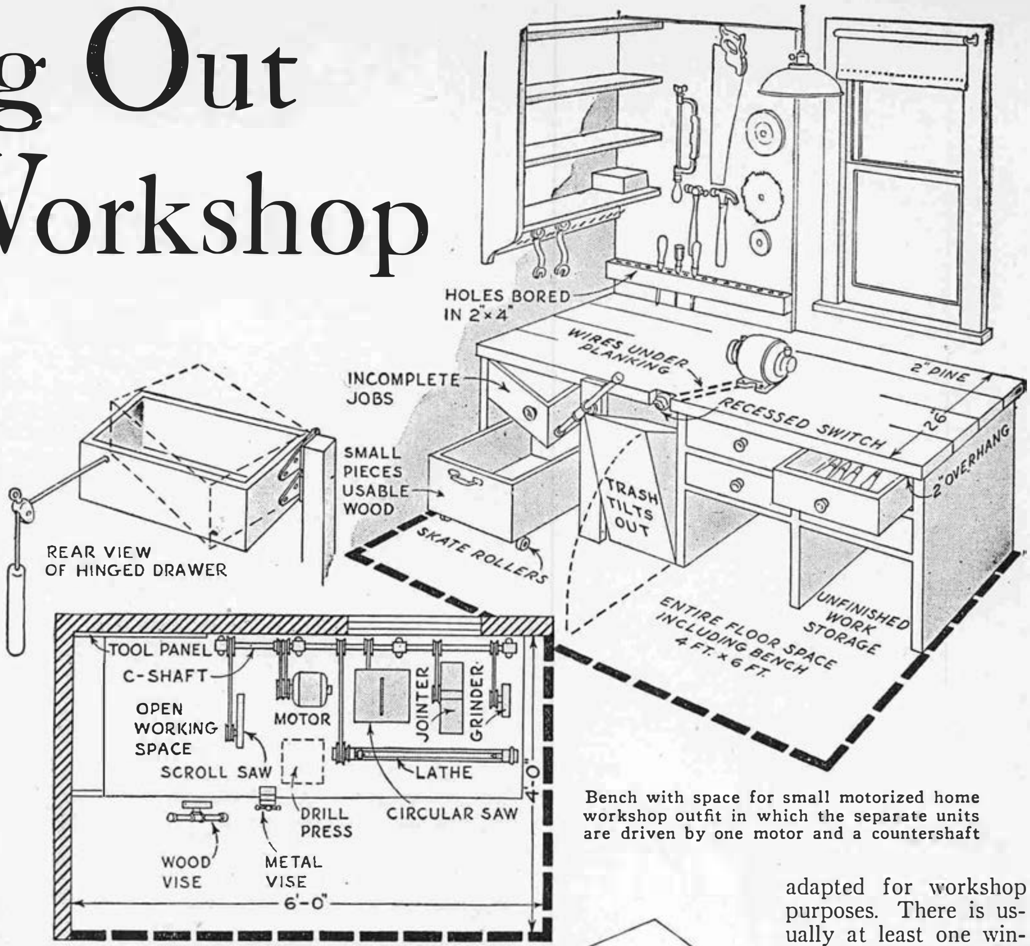
The matter of getting proper light is extremely important. Have the light evenly diffused from both sides, and check each measurement from two positions if possible.

Laying Out a Workshop

EVEN if you have only a small corner about 4 by 6 ft. in a spare room, screened porch, woodshed, cellar, or attic, you can lay out a satisfactory workshop with machines of the smaller sizes. A porch, if available, can be inclosed with wood wainscoting and glass windows obtained from a wrecking yard. It can then be comfortably heated with a so-called "hot-air" stove, which burns paper, shavings, odds and ends of wood, or coal. A new one can be bought for less than $2. Only as a last resort should an attic be used for your shop.

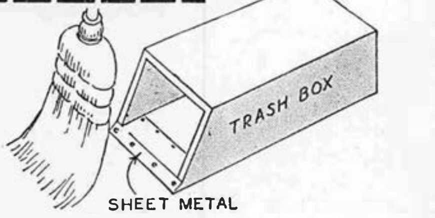
The accompanying plan shows the arrangement of one of the popular complete workshop outfits having one motor and countershaft — a small, moderately priced outfit. All the units can be arranged in a compact space. The bench should be about 34 in. high, or whatever measurement suits the height of the user.

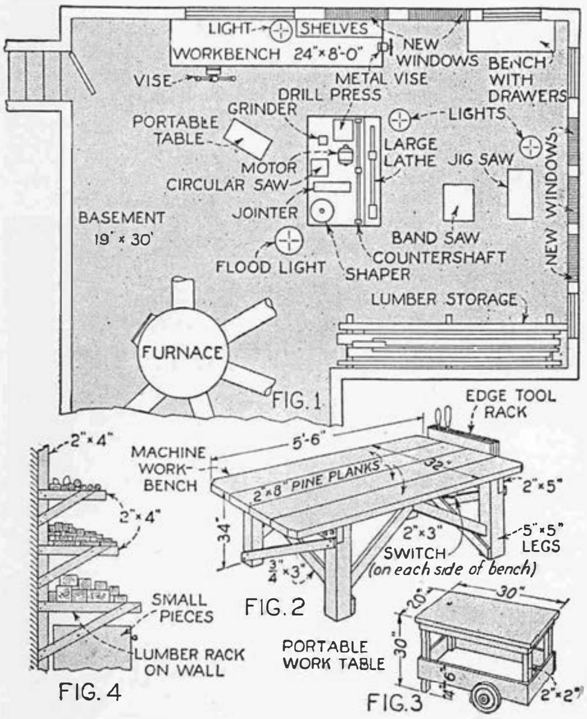
In another drawing is shown the arrangement of shelves and drawers, and a tool panel on the wall. Small parts are kept in glass jars, heavier ones in boxes.



Bench with space for small motorized home workshop outfit in which the separate units are driven by one motor and a countershaft

Plan of a 4 by 6 ft. shop designed to take a standard small outfit of woodworking machines with a drill press added. Details are given of a hinged drawer and trash box





Floor plan showing a step-saving layout of machines in a basement; and the bench, portable table, and lumber rack

In the ten-cent stores a handy three-compartment box can be purchased and labeled on the end, or one of the parts kept in each compartment can be wired on the outside instead of a label.

A swinging drawer, installed as shown, has been found a great convenience. Below this drawer is a large box on skate rollers that can be pulled out easily, giving access to a stock of short pieces of wood.

The tilting trash box illustrated is another handy accessory, because it can be laid flat on the floor like a huge dust pan and the shop litter swept into it over the lip.

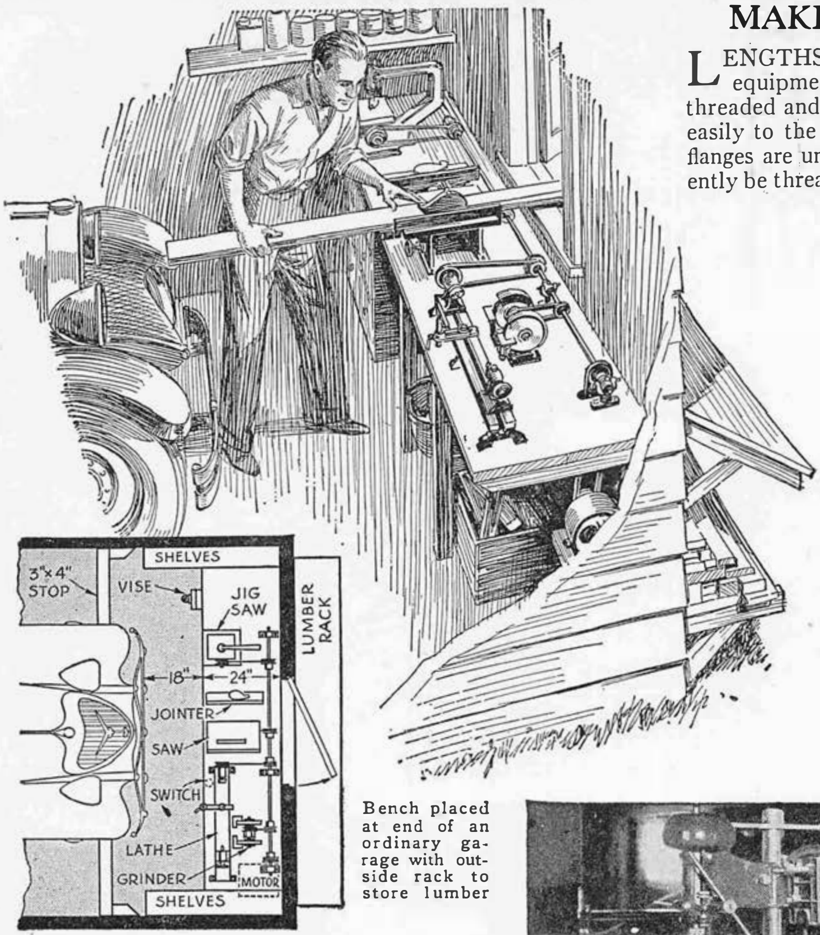
About the simplest and least expensive home workshop for the beginner is a bench across the *end* of the garage, not the side. Most garages are somewhat longer than the over-all size of modern automobiles, and this extra space is admirably adapted for workshop purposes. There is usually at least one window for daytime light. A 3 by 4 in. timber installed across the floor serves as a stop to keep the car from encroaching on the little shop, and at the same time prevents shavings and debris from littering the space rightfully belonging to the car.

A workbench built of 2-in. planks, which are about 1⅝ in. actual thickness when surfaced, is much more desirable than one of ¾-in. stock. It should be well braced and have at least two 2 by 4 in. legs in addition to the end supports. Tool drawers and shelves should be included.

The first workshop often includes a lathe and a circular saw. On this assumption, arrange these machines as shown in the plan drawing, with the motor below the bench to conserve space. The diagram indicates convenient locations for other machines as they are acquired from time to time. They can be driven from the initial motor by adding to the countershaft. Note that the circular saw and jointer are installed opposite the window so that long boards can be passed through it.

An open lumber rack with a roof can be built on the outside of the garage, as shown, and short pieces may be kept out of the way in boxes under the bench.

When ample space is available for a basement shop, the problem is to concentrate the equipment sufficiently to save unnecessary steps, yet leave room enough to operate all machines freely. The shop which is illustrated in the photographs and the floor plan is a good example for those who can buy only one machine at



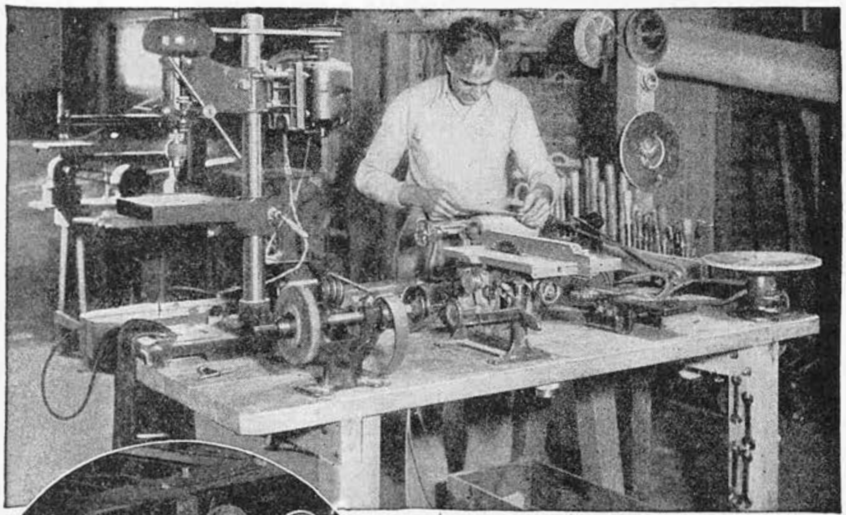
Bench placed at end of an ordinary garage with outside rack to store lumber

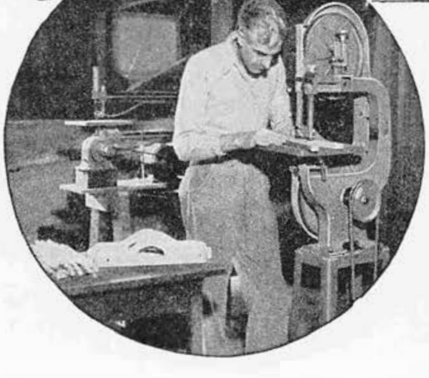
a time. A somewhat different layout from Fig. 1 might be made, of course, if all the equipment could be bought and installed at once.

A LARGE homemade lathe was the first machine acquired. Then were added a jointer, circular saw, grinder, shaper, and drill press. These are grouped on a substantial bench built as shown in Fig. 2. Some of the machines have individual drives, but most of them are driven from a countershaft powered by a ½-H.P. motor.

A band saw and a large jig saw have individual drives and are placed to best advantage in respect to light and handling room. A portable worktable, Fig. 3, facilitates carrying work from one machine to another. Lumber is stored on a rack built as in Fig. 4.

The artificial illumination is exceptionally well distributed, and the daylight is to be increased by putting windows in the foundation as indicated by the shaded portions of the diagram showing the general arrangement of the shop.





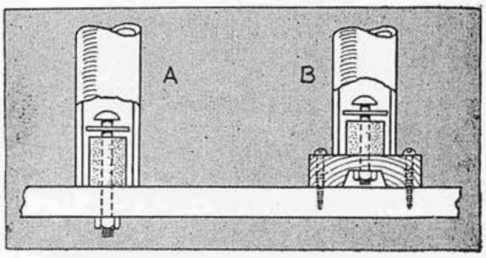
Two views of a well laid-out basement workshop. Jig saw, Band saw, and drill press have individual motor drive; the other machines are run from a countershaft that runs along the top of bench

MAKING BENCH LEGS OF PIPE

LENGTHS of pipe make serviceable bench legs and supports for equipment to be used in the shop or garage. If the ends are threaded and floor flanges are at hand, the legs may be fastened easily to the floor, wall, or bench top, but difficulty arises when flanges are unobtainable or the cut length of pipe cannot conveniently be threaded. In that case, one of the methods illustrated may be used.

A carriage bolt is inserted into the end of the pipe, head first, and a washer, nearly as large as the inside of the pipe, is added. Then a short length of garden hose is slipped over the bolt. The leg is set in place, and the bolt is thrust through a previously bored hole in the bench top or flooring, as shown at *A*. Tightening a nut on the bolt will draw the head downward, compressing the hose and making it grip the sides of the pipe tightly.

When a nut cannot be applied to the opposite side of the supporting surface, the bolt is fastened to a counterbored wood block, as shown.

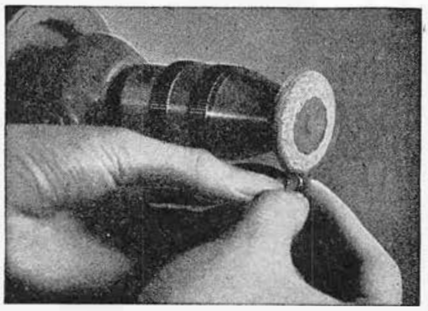


SPECIAL FILM MAKES SHARP ENLARGEMENTS

NEEDLE-SHARP enlargements may be assured by the use of a focusing film. Soak an ordinary film—one that has been discarded—in warm water and rub off the emulsion. Then, after the film has dried, use a draftsman's ruling pen and India ink to rule a pattern of squares and diagonals on what was formerly the emulsion side. By projecting this test film the easel may be accurately adjusted and the focus set.

KEEPING CHEMICALS DRY

CHEMICALS that have a strong affinity for water and are usually difficult to keep in a dry state may be preserved by storing them in wide-mouthed bottles. Tamp a wad of cotton into the bottle so as to fill the neck, and then pour in a little melted paraffin. This gives a seal that is more secure than dipping the stoppered bottles in paraffin because there is no cork to loosen accidentally.



POLISHING WITH ERASER

A FLAT typewriting eraser is an excellent substitute for a polishing wheel in cleaning up delicate metal parts of models and other small work. Such an eraser is soft and just gritty enough to polish without endangering the piece. The eraser is mounted on a wood screw, which in turn is held in the polishing-head chuck.

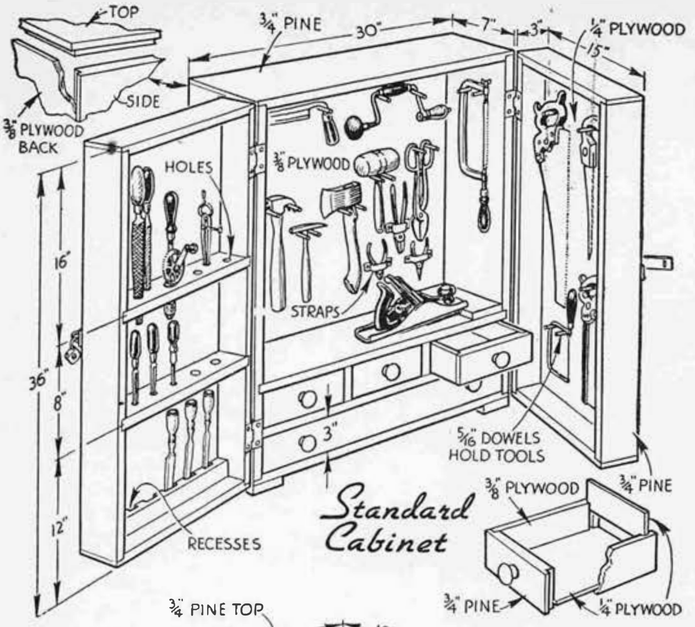
Good Tool Cabinets

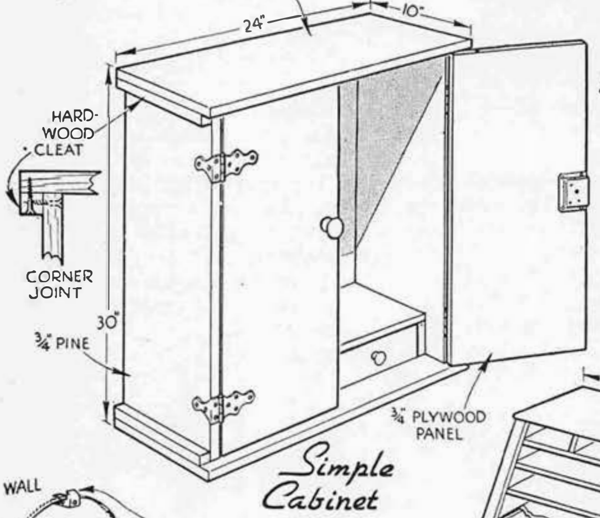
IMPROVE YOUR SHOP

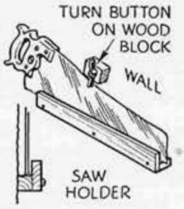
THESE tool cabinets and tool boxes are designed to meet a wide range of needs. In each case individual racks and pegs should be arranged to hold the tools on hand. Sturdy construction is required for the doors and swinging tool panels, and all hinges and angle brackets must be heavy, because there is considerable weight when the tools are in place.

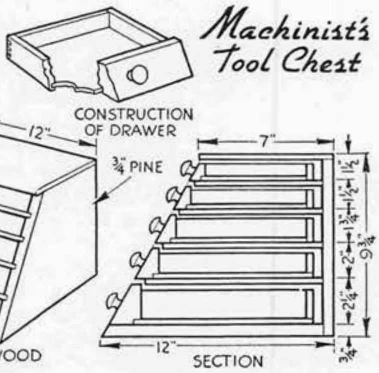
A compact carrying case for small tools, such as end wrenches, dies, drills, and chisels, is illustrated in the lower left-hand view. In the lid, a rod or stiff wire prevents the tools from falling out. The front is of heavier material than the sides so that it will stand the strain when the box is carried by the handle.

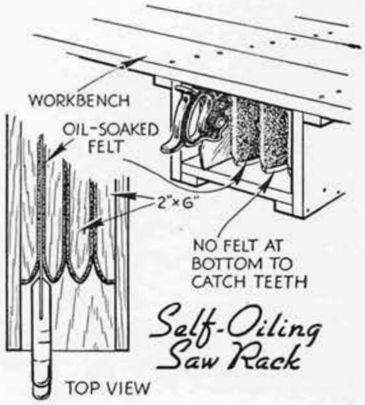
If tools are kept in a damp cellar, they should be kept in a cabinet with a snug door. Some mechanics place a pan of kerosene under their handsaws to prevent rust; others use a self-oiling arrangement.

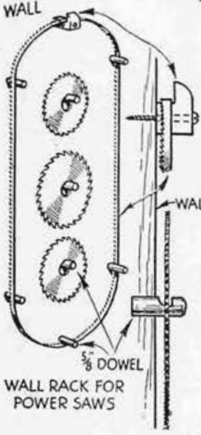

Standard Cabinet

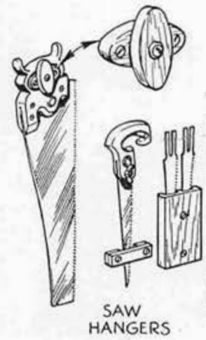

Simple Cabinet

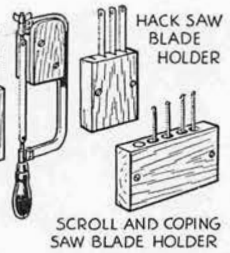


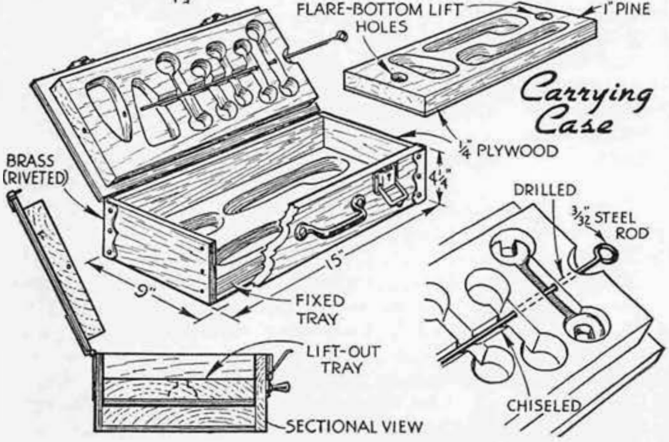

Machinist's Tool Chest

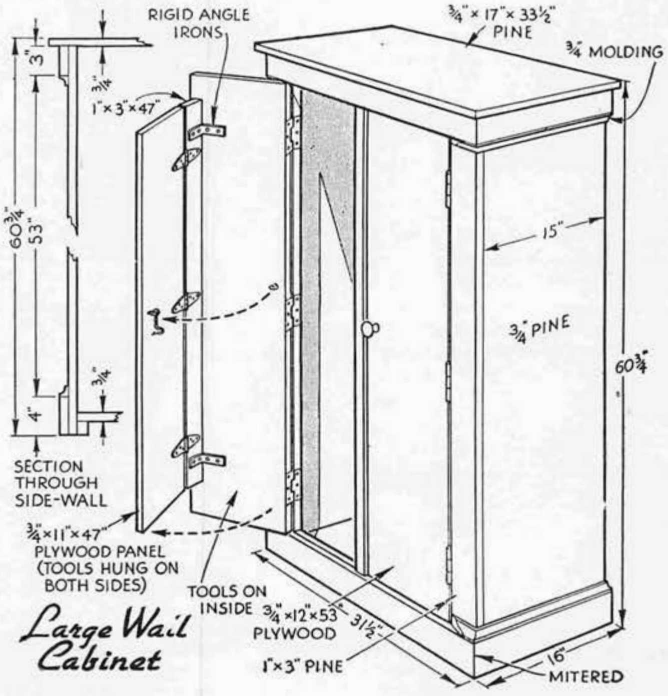

Self-Oiling Saw Rack





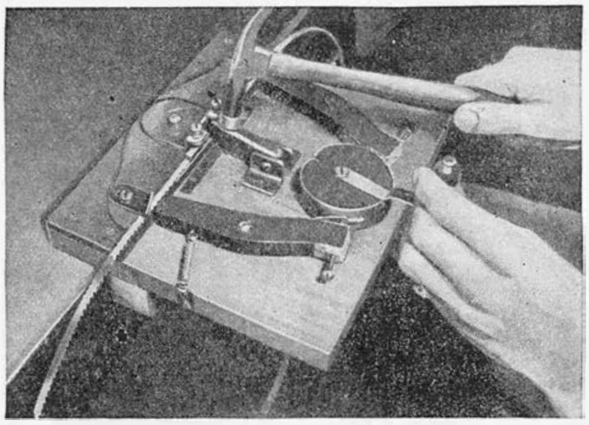



Carrying Case


Large Wall Cabinet

Machine *for* Setting Band Saws

SETTING band saws by hand is a difficult and tiresome task, but the homemade machine illustrated enables any band saw from ⅛ to ½ in. wide to be set accurately, quickly, and easily. One turn of the cam at a time aligns every other tooth over the anvil, and a light tap on the anvil hammer with a small hammer then sets the teeth. After half of the teeth have been set, the saw is turned over and the other half are set the opposite way merely by engaging the finger of the cam follower on the opposite side.

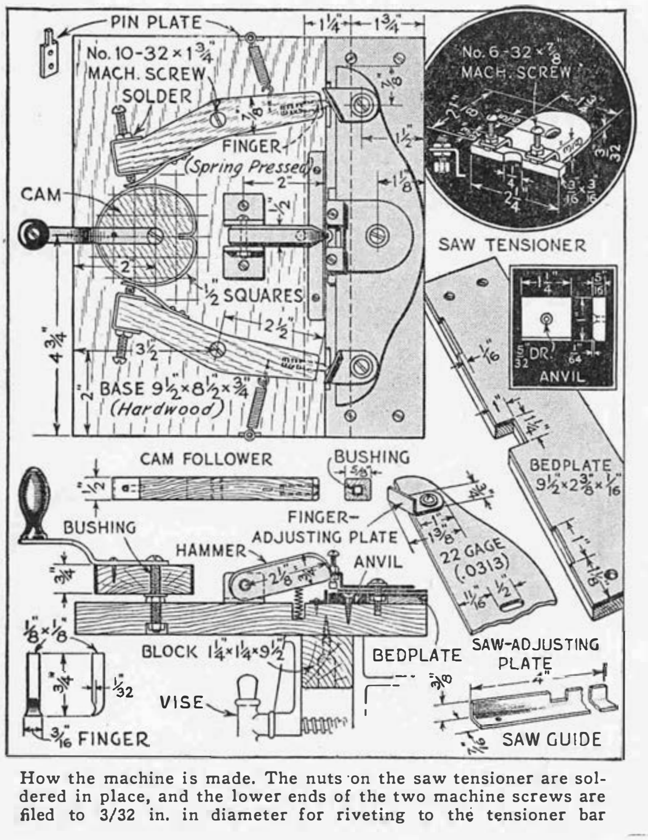

Setting a ¼-in. band saw with the device. The anvil is tapped, then the handle is turned to move the blade along two teeth more

The construction is clearly shown in the drawings below. Use hardwood for the base and other wooden parts. A piece 1¼ by 1¼ by 9½ in. is screwed under the base as indicated. To the upper side glue and nail a piece ¼ by 2⅜ by 9½ in., the piece being cut out to fit the anvil. The square nuts for the machine screws that hold the sheet-iron adjusting plates and the saw tensioner in place are fitted into the wood as indicated and held with the bedplate.

The anvil and hammer are made from steel and hardened after being filed to shape and drilled. The mounting for the hammer is made from ¾-in. angle iron. The saw guide is formed from 1/32-in. brass and screwed in place against the anvil.

The cam is cut from a piece of wood ¾ in. thick, and the edge is bound with a piece of brass 1/32 by ¾ by 8 in., the ends being bent and soldered into a slot, which is cut in the lowest point of the cam. The cam rise is ⅝ in.

Make the cam followers from ½ by 3 by 5½ in. wood. Drill holes for the bushings, which must be a free fit on the machine screws. Re-enforce the cam end with brass, and solder the machine screw nut to it as shown. On the finger end, insert a piece of square brass tubing measuring ⅛ in. square on the inside. File the finger from a piece of steel to the dimensions given. This is then hardened. The small springs that keep the finger in contact with the saw are taken from tire valves.



How the machine is made. The nuts on the saw tensioner are soldered in place, and the lower ends of the two machine screws are filed to 3/32 in. in diameter for riveting to the tensioner bar

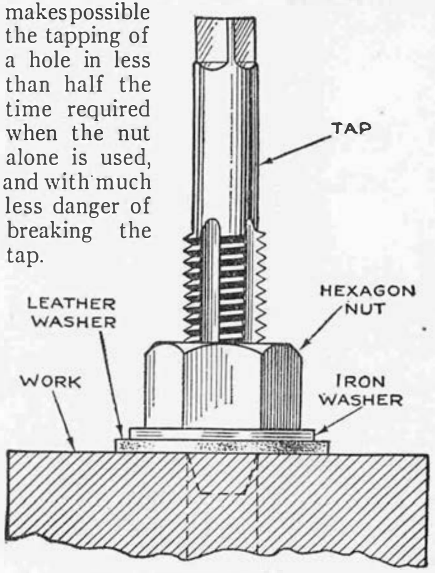
After the machine is assembled and the saw put in place, the adjustments necessary will readily be seen. If the tooth does not align directly under the hammer, a slight turn of the screw on the cam follower will bring the tooth in line for setting. After this has been done, the adjusting plate must be set so the finger will take every second tooth with one turn of the cam.

The tension on the saw is controlled by raising or lowering the tensioner bar. If ⅛ in. saws are to be set, an extra plate is placed under the saw tensioner. This is cut from 3/32-in. iron in the same general shape as the saw tensioner, but is flat except for a 1/32-in. lip, which is turned down along the front edge.

A little studying of the machine will soon familiarize one with its working, and the setting of band saws will thereafter be easy to do.

NUT AND WASHERS SERVE AS GUIDE FOR TAP

IT IS difficult to tap a hole by hand so that the threads will be square with the face of the work, no matter how true the hole is drilled. Some mechanics who happen to know the kink make a practice of facing the bottom of a nut and screwing it on the tap. Then they gradually turn the nut up as the tap goes down. Unfortunately, the tendency of the nut is to lock the tap so that the process is slowed down. This difficulty can be completely remedied, however, by the simple expedient of placing a flat iron washer against the bottom of the nut, after it has been screwed on the tap, and then adding a second washer of shoe leather. The latter, which comes in contact with the work, is so elastic that it keeps the tap from being locked by the nut, while the intervening iron washer prevents the nut from tearing the leather. With this assembly the nut can be screwed down tight enough to keep the tap vertical, but will not lock the tap; therefore it makes possible the tapping of a hole in less than half the time required when the nut alone is used, and with much less danger of breaking the tap.



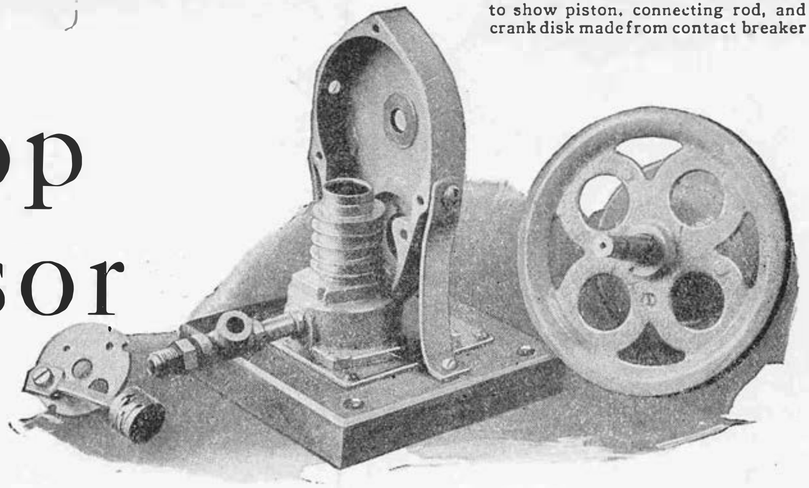
A leather washer prevents a nut from becoming locked when used as a guide for tapping

VINEGAR CLEANS BOILER

FOR cleaning and removing scale from inside a house-heating boiler and pipes, here is a method that increases the efficiency of the boiler and saves coal. In the fall, after the firing season has begun, drain all water from the boiler, remove the steam or pressure gage, and, using a funnel, add 5 gal. of bulk vinegar, which is sufficient for the average boiler. The gage is then replaced and the boiler filled with the usual amount of water. This mixture is allowed to remain in the boiler for six days of firing; then the boiler is drained and flushed out thoroughly with clean water.

OLD MAGNETO PROVIDES PARTS FOR BUILDING

Small Workshop Compressor

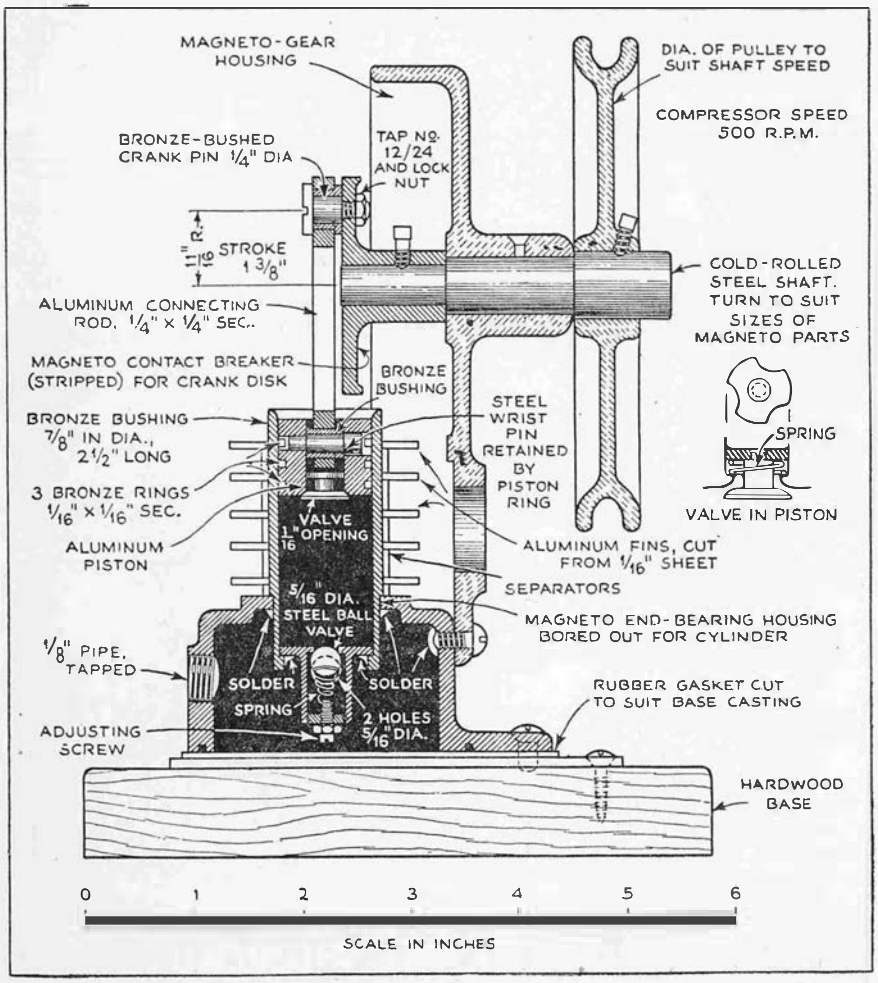


The compressor partly disassembled to show piston, connecting rod, and crank disk made from contact breaker

MADE entirely out of scrap materials, the small compressor illustrated will raise a pressure of 25 lb. per sq. in. in a 6-cu. ft. tank in 25 minutes, which is ample for the average small gas torch. The consumption of line-shaft power is very small, an important consideration in many small shops.

Construction of the compressor is clearly shown in the photograph and large drawing below. Simplicity is the keynote of its construction throughout. The magneto which supplied most of the larger parts was purchased for fifty cents.

The method of procedure will be governed to some extent by the type of magneto available. Assuming the gear housing to be of cast iron and the end bearings to be of brass, it is a simple matter to saw and file out the gear housing to fit on the end bearing housing as shown. The two are fastened by a machine screw after being sweated together with soft solder. To do this successfully, the cast iron must be thoroughly cleaned and well tinned. The axis of the shaft hole in the gear housing must be kept parallel with the finished face of the brass base. Do not fasten these parts together permanently at this stage.


MAGNETO-GEAR HOUSING
BRONZE-BUSHED CRANK PIN 1/4" DIA
TAP NO. 12/24 AND LOCK NUT
11/16" R.
STROKE 1 3/8"
ALUMINUM CONNECTING ROD, 1/4" × 1/4" SEC.
MAGNETO CONTACT BREAKER (STRIPPED) FOR CRANK DISK
BRONZE BUSHING
BRONZE BUSHING 7/8" IN DIA., 2 1/2" LONG
3 BRONZE RINGS 1/16" × 1/16" SEC.
ALUMINUM PISTON
STEEL WRIST PIN RETAINED BY PISTON RING
VALVE 1/16" OPENING
5/16" DIA. STEEL BALL VALVE
1/8" PIPE, TAPPED
SOLDER
SOLDER
SPRING
2 HOLES 5/16" DIA.
ADJUSTING SCREW
DIA. OF PULLEY TO SUIT SHAFT SPEED
COMPRESSOR SPEED 500 R.P.M.
COLD-ROLLED STEEL SHAFT. TURN TO SUIT SIZES OF MAGNETO PARTS
SPRING
VALVE IN PISTON
ALUMINUM FINS, CUT FROM 1/16" SHEET
SEPARATORS
MAGNETO END-BEARING HOUSING BORED OUT FOR CYLINDER
RUBBER GASKET CUT TO SUIT BASE CASTING
HARDWOOD BASE
0
1
2
3
4
5
6
SCALE IN INCHES

Chuck the base in the lathe and bore for the cylinder. The size depends upon the bushing used for a cylinder, but the drawing indicates the proportionate allowances to be made for shoulders and the like.

The next step is to turn, bore, and lap the cylinder to an inside diameter of 7/8 in., with other dimensions to suit the actual bushing available.

The cylinder bottom is soldered into place after fitting the simple ball valve. Make the valve seat very narrow, use a new ball, and tap the ball lightly on its seat before assembling to insure a tight valve.

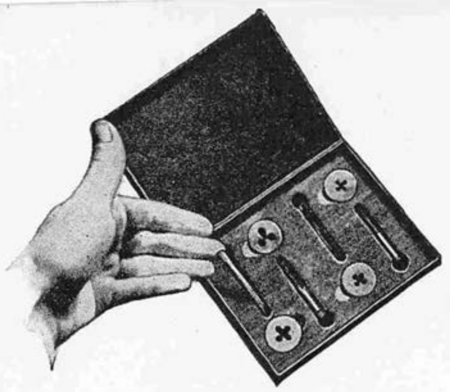
Mount the cylinder in the base and solder as shown. Care must be taken to see that the bore is at right angles to the finished face of the base. Note the aluminum cooling fins, which can be turned in the form of washers and threaded on the cylinder before mounting, with aluminum separators between them.

The piston is built up from 1/8 in. sheet aluminum cut into disks 7/8 in. in diameter and riveted together. The rivets must be so placed that they will not interfere with the ring grooves or the piston-pin hole. The inlet valve in the base of the piston is retained with two turns of very light steel spring sprung into a groove just above the valve seat. The ring grooves are turned 1/16 in. wide and 1/16 in. plus .002 in. deep. The rings are 7/8 in. in diameter and 1/16 in. thick, split at an angle of 45 deg. and sprung over the body into place, care being taken not to deform them.

The connecting rod is also built up out of the 1/8-in. aluminum sheet, two pieces being riveted together through the center section. The ends are left square in section as shown in the photograph and are fitted with bronze bushings for suitable pins, as indicated in the drawing.

Care is necessary to insure that all joints are air-tight, because with such a small displacement a very small leak will seriously cut down the efficiency of the compressor. The best running speed is about 500 r.p.m.

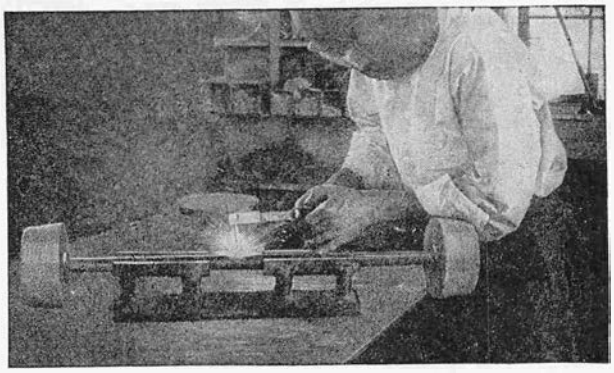
The lightness of the oscillating parts and the comparatively heavy driving pulley, acting as a flywheel, reduce vibration to a minimum, but the braces shown are necessary to give general lateral stiffness. They are bent out of 5/8-in. flat steel 1/8 in. thick, and fitted into place.



NEAT TAP-AND-DIE CASE

To PROTECT small taps and dies, a case can be made from a so-called "flat fifty" cigarette tin and a piece of plywood with jig-sawed recesses for the tools.—

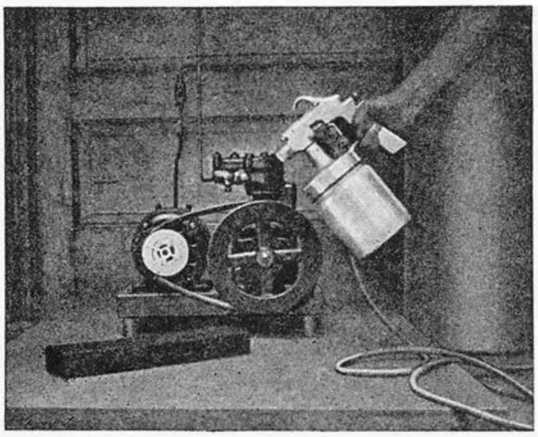
RAISED V-BLOCK FOR WELDING AWKWARD WORK



A gap-type V-block made from one long angle, four short lengths of tubing, and two short angles. It holds a large variety of work

MOST welders use V-blocks which they have made themselves from ordinary angle stock with the corners welded together. If short lengths of tubing are welded between the angles as shown in the accompanying illustration, it will make them more useful, particularly in working on objects having projections of any sort at one or both ends. A good plan is to use one long V as a base and fasten two short ones to it, with a space left between the small angles. This makes a doubly convenient fixture.—

OLD REFRIGERATOR UNIT SUPPLIES AIR



This compressor is from an old refrigerator and cost five dollars, and the tank was bought from a junk yard for three

EVERY home workshop enthusiast can find many uses for a ready supply of compressed air. From parts that are probably available in your local power company's junk pile, a serviceable compressor and storage tank can be made. This old refrigerator unit was purchased for five dollars and an old pump tank and control from a junk yard for three dollars. The pressure gauge and pressure relief valve are not essential, but make a better job.

Although the compressor shown is a twin, a single will do. Take the compressor apart, tighten the bearings if they are loose, and reassemble. The valves on most domestic compressors are located on a plate in the head. Polish the seats of the discharge and suction valves by rubbing the valve plate on a pieces of 400 emery paper lying on a flat surface. Put in new valve reeds and gaskets, and reassemble the head. Light motor oil should be used in the compressor.

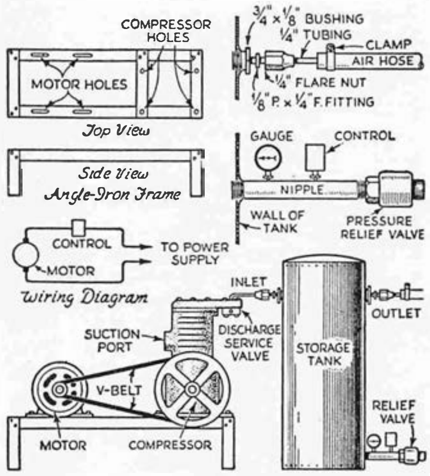
If the bearings in the motor are bad, press in new ones. New brushes often help a motor and, if you have access to a lathe, the commutator should be turned down and palished. If you true up the commutator, cut out about 1/16 in. of the mica between the strips. The motor and compressor shown in the photograph are mounted on a board with pipe legs, but a frame made out of angle iron and strap iron is better. Slot the holes for the motor bolts so the belt may be tightened.

Most tanks have at least three holes; the one shown had three ¾-in. holes. With a bushing, reduce the size of the inlet and outlet so that a ⅛-in. pipe by ¼-in. flare fitting can be screwed into them. On the third hole use a ¾ by 6-in. nipple, and tap two holes into it to take ⅛-in. pipe threads. These holes are for the pressure gauge and the pressure control. The relief valve is screwed on the end of the nipple. Use litharge and glycerine on all joints.

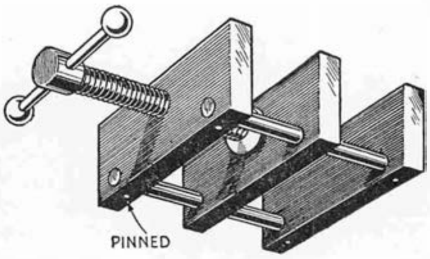
Connect the discharge port of the compressor to the air inlet of the tank by a ¼-in. piece of copper tubing. The suction port of the compressor is left open.

Start the motor to find at what pressure the control shuts off the engine. On most controls, adjustment is made by turning a nut which varies the tension of a spring. Adjust the control to shut off at a convenient pressure, which in this case is 50 lb. The relief valve should be set to blow off at a pressure less than the rated working pressure of the tank.

No dimensions have been given because they can be arranged to suit the equipment at hand. After a little experimenting, you will be able to adjust the control to suit your requirements.



How the entire outfit is set up; details of the fittings and stand; and a wiring diagram

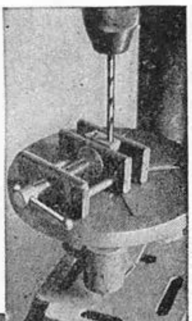


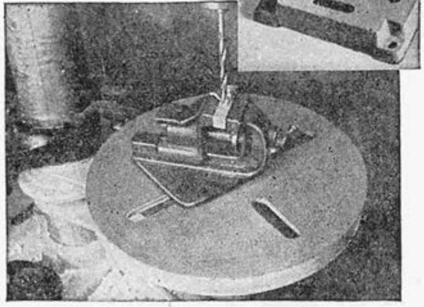
TWO INEXPENSIVE VISES FOR THE DRILL PRESS

ATTEMPTS to hold small work on a drill-press table by hand often results in bruised fingers. A vise should be used, and in the absence of a suitable commercial vise, there are two ways in which one can easily be made.

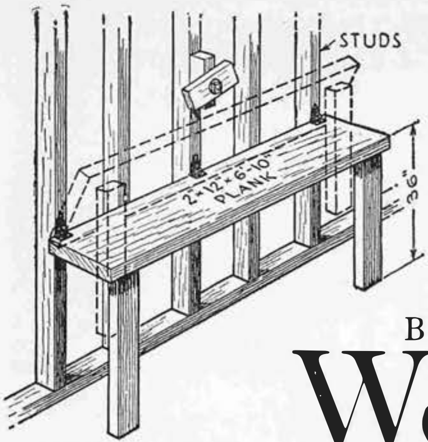
The first method is to cut the C-clamp off the bottom of a cheap bench vise and fasten the vise proper to a flat base plate with flathead machine screws.

A more versatile vise may be made by taking the lead screw from a machinist's C-clamp or using any suitable bolt. Three rectangular pieces of steel of convenient size are firmly clamped together, and the ends filed flat and square so that the vise can be used on its side. To assure alignment, the holes for the two round guide rods are drilled while they are clamped. The joints preferably should be reënforced by brazing or else sweated together with solder and a flux of muriatic (hydrochloric) acid "killed" with zinc.

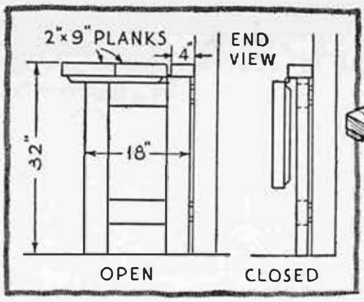


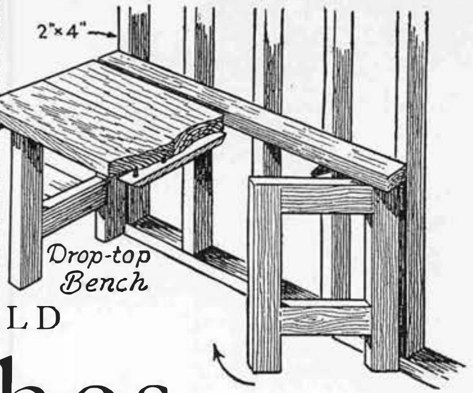


A drill-press vise made from a cheap bench vise, and, above, an even more useful design



Folding Bench for Narrow Garage

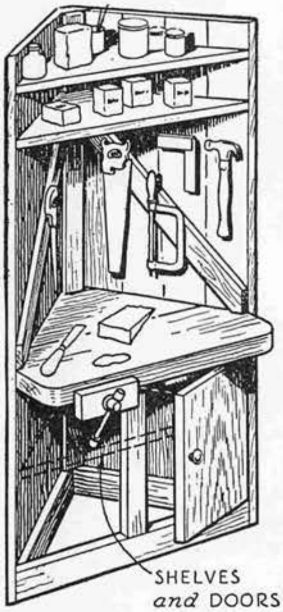




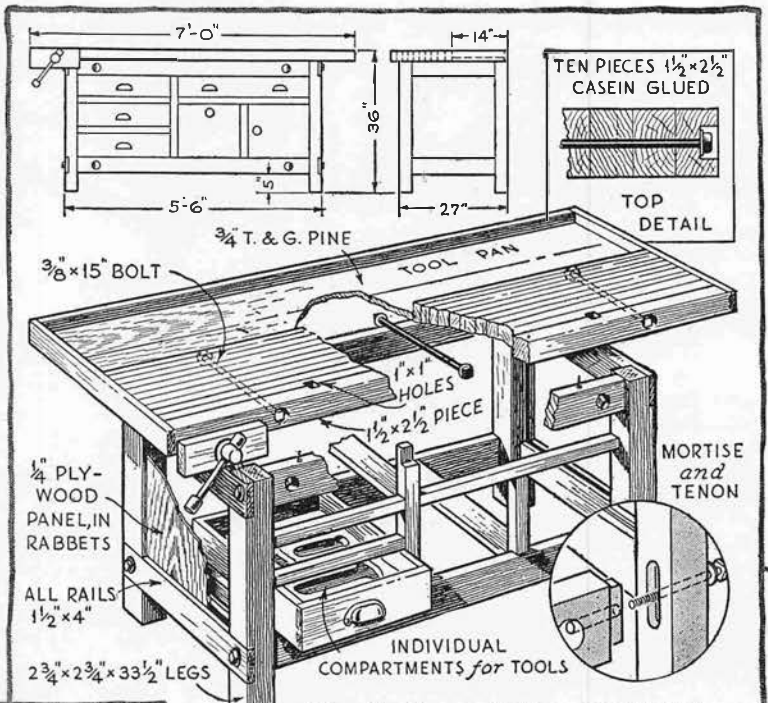
Drop-top Bench

BETTER WAYS TO BUILD

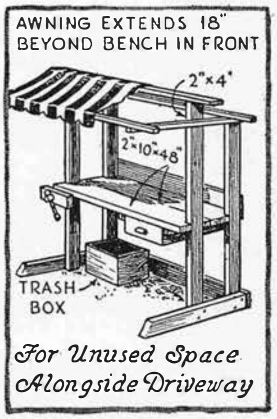
Workbenches



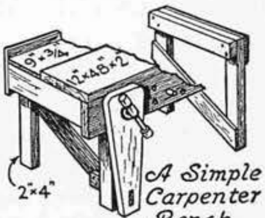
Portable Corner Work Cabinet for House Use



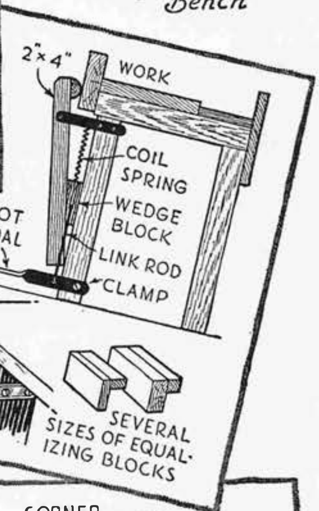
Sturdy General Purpose Bench

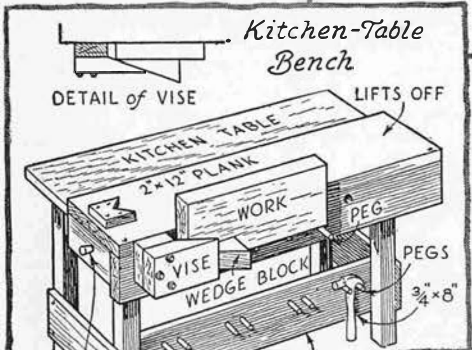


For Unused Space Alongside Driveway

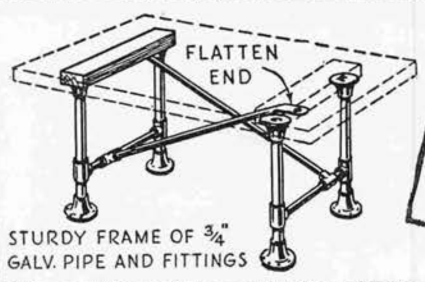


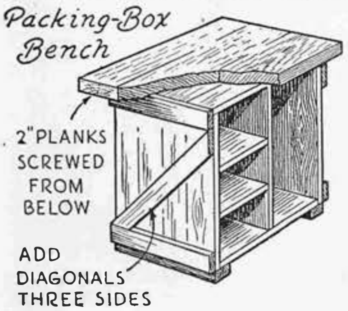
A Simple Carpenter Bench



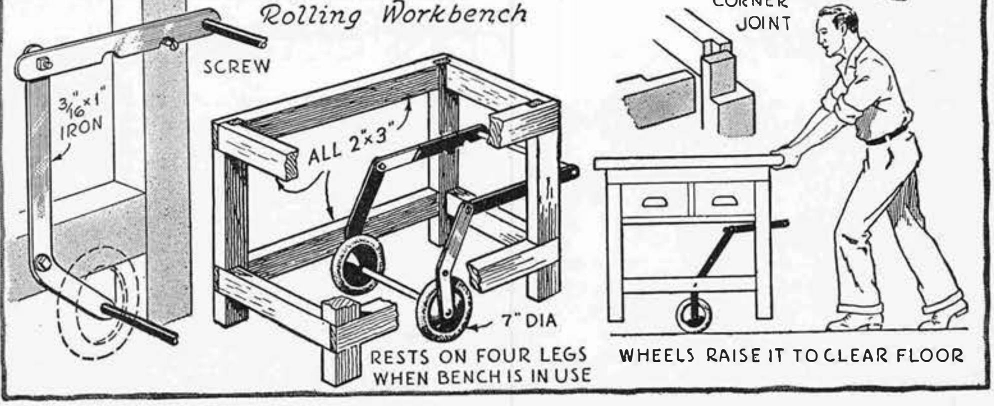


Kitchen-Table Bench



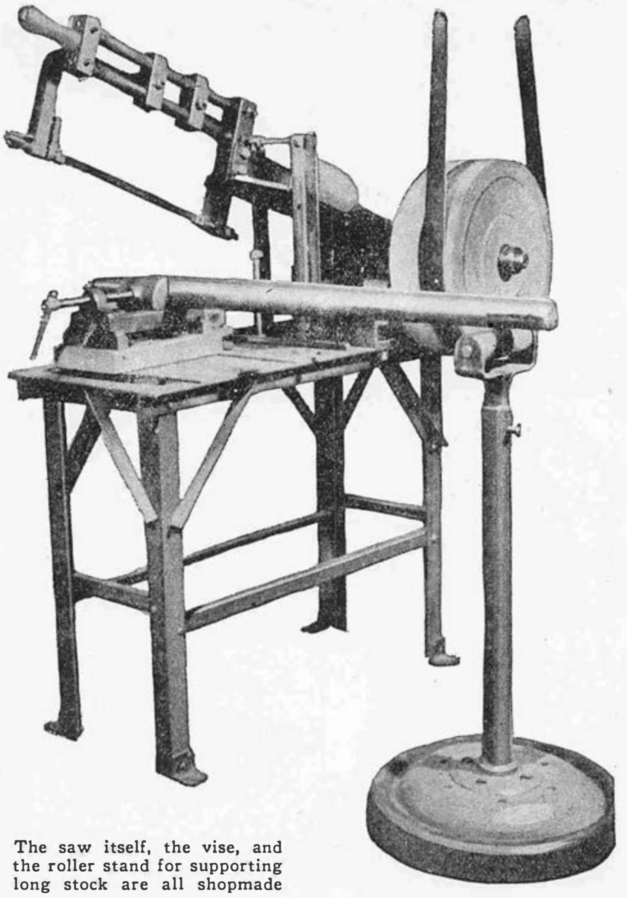


Packing-Box Bench


3/16"×1" IRON
SCREW
ALL 2"×3"
7" DIA
RESTS ON FOUR LEGS WHEN BENCH IS IN USE
CORNER JOINT
WHEELS RAISE IT TO CLEAR FLOOR

Rolling Workbench

Sturdy Power Hack Saw Built at Low Cost



The saw itself, the vise, and the roller stand for supporting long stock are all shopmade

THIS homemade power hack saw has given satisfactory service for several years and has even sawed off several pieces of railroad iron, which shows that it is built for real work.

The stand is rigidly constructed from 1¼-in. angle iron and is braced with ¾-in. angle iron. The stand is 24 in. long, 10½ in. wide across the top, and 18 in. high. Six-inch band iron is riveted across the top to hold the vise, bearings, and the stop to keep the saw from dropping when through the cut.

The saw frame is made of ¾-in. square cold-rolled steel, measures 12¼ in. long inside, and takes a standard 10-in. hacksaw blade. It is 5 in. deep, and the end pieces that hold and tighten the saw are turned from ½-in. square cold-rolled steel. A square head is left for the saw, and the shank is turned down to ⅜ in., the whole length of the holders being 3½ in. The guides on the saw holders for keeping the saw straight can be seen in the illustrations and may be made from mild steel, drilled and ground to shape.

A slot for the saw can be sawed into the saw holders with the same saw that will be used in the machine. Piece of an automobile wind-shield wiper rod makes an ideal pin to fasten the saw at the ends. As this pin is quite hard, the saw will not cut into it.

The slides that support the saw frame are made from 1-in. square cold-rolled steel and are 2⅝ in. long. The slide rods are ⅝-in. round cold-rolled steel and are 10¼ in. long between end pieces. The slides and end pieces are drilled 1½ in. on centers; one piece is marked out and drilled, and that one is used as a template to drill all the rest by.

The bearings are ¾-in. pillow blocks bought from a large mail-order house. Two pillow blocks are used as main bearings, and a third is bolted to the angle-iron arm that is used to raise and lower the saw. This third bearing goes on the ¾-in. shaft between the main bearings, and is mounted upside down and bolted to the bottom of the angle-iron arm. The two main pillow blocks are supported on two hardwood blocks 5½ in. long and 3 in. high, the bearings and the wooden blocks being bolted to the 6-in. band iron.

The crank is made of 1-in. square cold-rolled steel, and the holes for the shaft and crank pin are drilled 2½ in. on centers. Designed to give the saw a 5-in. stroke, the connecting rod is made from ¾-in. square cold-rolled steel and is 9¼ in. long; it is turned down round between the heads.

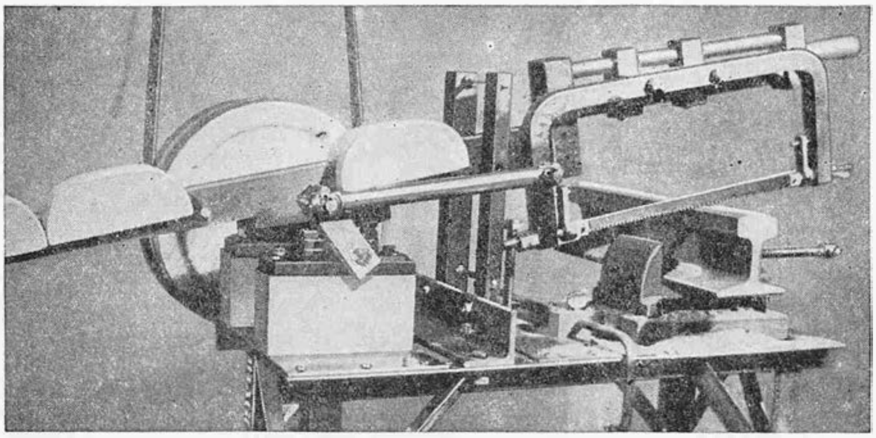
Guides to help take the side strain from the bearing that holds the raising and lowering arm are made from 1-in. angle iron and are 10½ in. long. The guides are supported on a piece of 2-in. angle iron, bolted to the stand. Lead weights are cast in a wooden mold and are used as shown to serve as counterweights.

The pulleys are made of wood. The tight pulley is bolted to a flange, and the flange fastened to the shaft with a set screw. The loose pulley has a Babbitt metal center that runs on the shaft.

The vise to hold the work may be purchased or it can be made, as by the writer. A pattern was prepared and the casting ordered from a foundry.

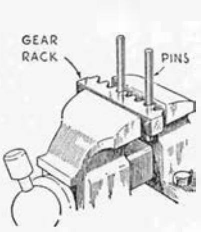
The stand to support long stock was assembled from pipe. It has a roller at the top, and an old automobile brake drum is used as a base.

With this brief description on hand, any machinist who wishes to add a similar power hack saw to his shop equipment will have little difficulty in working out the details of the construction. The dimensions may, of course, be changed to suit the builder's ideas.



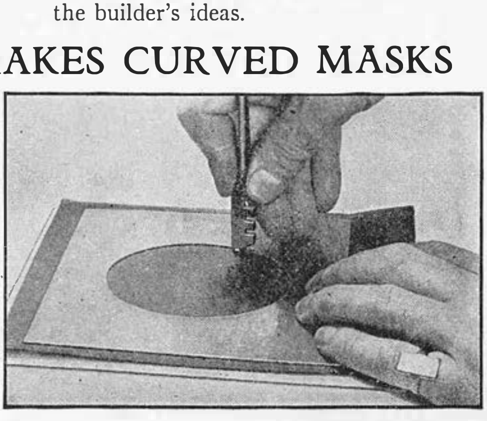
Even stock as heavy as steel rails can be cut without difficulty. Note the lead counterweights

BENDING JIG FOR VISE



FOR bending and shaping large wire or the smaller sizes of metal rods or bars, an improvised bending jig like that shown is useful. It consists of a portion of an old gear rack and two or more bolts or steel pins. The rack is placed along one jaw of the vise, and the pins are clamped between the teeth at the desired distance apart.

GLASS CUTTER MAKES CURVED MASKS

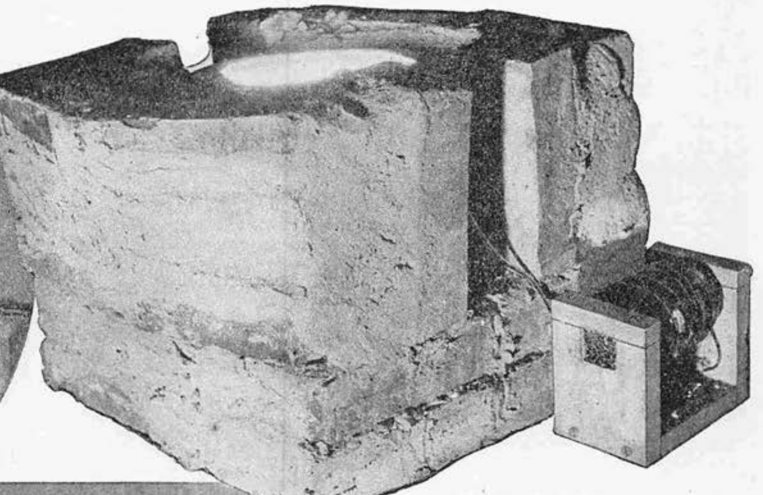


WHEN you wish to cut ovals or circles in paper, as in making black paper masks for photo printing, try using a glass cutter instead of a knife or razor blade. It will follow any curve with ease and make an absolutely clean cut. Place the paper on a sheet of glass, as shown in the illustration. If a number of masks are to be made, you can use a metal template as a guide. It is necessary, of course, that the cutter be in good condition and have a well-sharpened wheel.

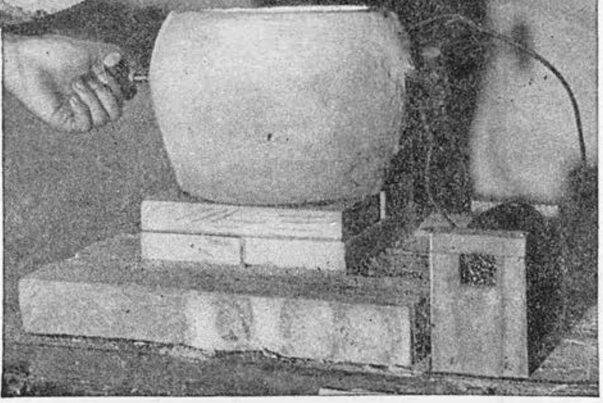
Small Portable Arc Furnace

Easily Built of Clay and Bricks

Use rubber gloves to avoid electric shocks and don't look at the arc itself unless you wear dark goggles



The furnace with cover removed. Chemical compounds can be prepared in small crucibles set on the bottom within the bowl



How the bowl is set up on bricks. A wood base should be provided so that the furnace can be carried easily by two persons

HOME workshop experimenters are often stumped for the lack of a high-temperature furnace. It is relatively easy, however, to build a furnace like the one illustrated, which develops about 2,300 deg. F. and satisfies all ordinary needs.

Preparing Clay Mixture. In a crock mix smoothly 5 lb. of kaolin, 20 lb. of fire clay, 25 lb. of silica (white sand), and enough water to make a plastic mixture. Remove about 15 lb. and pound it on a board until all air is forced out. Repeat with remainder. Allow to set over night, keeping it covered with a damp cloth.

Carbon Connections. Thread a 12-in. length of ¼-in. pipe, cut it in two, then drill and tap holes for set screws as shown. Fit wood handles on opposite ends and wrap with friction tape.

List of Materials

- 10 lb. kaolin or china clay (80c.)
- 100 lb. silica or white sand ($2)
- 100 lb. fire clay No. 1, pyrometric cone equivalent rating 30 (78c.)
- 4 fire brick slices (25c.)
- 40 common brick (50c.)
- 6 lb. powdered asbestos (30c.)
- 12-in. length of ¼-in. pipe and 2 nuts for ¼-in. pipe (50c.)
- 2 carbons, ¼ in. (30c.)
- 18 by 18 in. 10-gage metal (50c.)
- 6 alundum crucibles, 1-in. mouth ($1.20)
- 210 ft. (1½ lb.) bell wire (75c.)
- 150 ft. annealed iron wire, No. 14 (25c.)
- 1 by 5 in. board, 5 ft. long (15c.)

NOTE: The prices in parentheses are what the author paid. The fire clay and fire brick slices may be obtained from any oil-burner establishment.

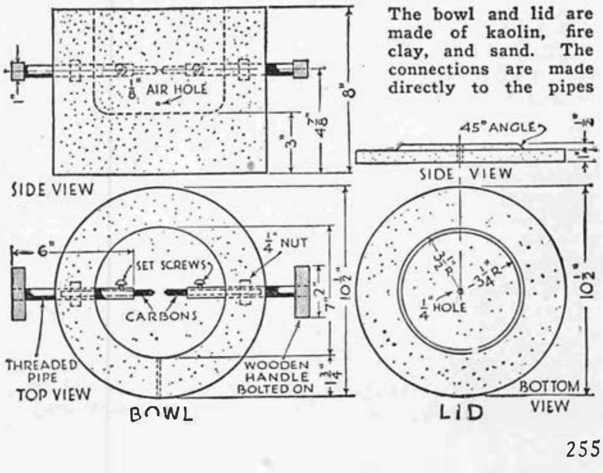
Construction of Bowl. Make a disk of clay 10½-in. in diameter and 3 in. thick. Form a strip 2 in. wide and 3 in. high. Place this on the base, all along the edge, and smooth with moistened hands. Lay the pipes and nuts on this wall directly across from one another and 4⅞ in. from the bottom surface of the base. Complete construction of the walls until 8 in. high. Construct the lid according to the drawings. Set all in a cool place for four days, then remove outdoors for a similar period.

Baking Clay. After they have been air-dried, place the leather-hard bowl and cover in a cool oven. Start with a temperature of 50 deg. F. Every hour and a half raise the heat 50 deg. until a temperature of 450 deg. is reached. Then reduce the heat 100 deg. every hour and allow the clay to cool slowly. When cool, drill the specified air holes.

Laying Brick. Lay common brick on sheet metal and fill in between them with clay. Prepare more clay, using same ratio as before. Set the bowl on the fire brick slices. Construct a brick wall around the first brick and bowl as shown. Pack between the bowl and brick with powdered asbestos mixed with water. Allow to dry thoroughly.

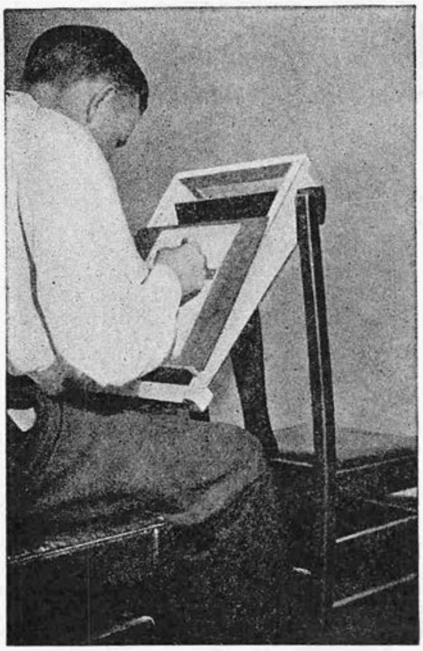
Reactance and Connections. This arc furnace needs a reactance to limit the amount of current passing through. Cut enough 1½ by 6-in. strips of soft iron or transformer steel to make a pile 1⅜ in. high, wrap with tape, and wind with No. 12 insulated wire until the coil reaches a diameter of 3¼ in. Connect on end of the reactance to a carbon, the other end, along with the second carbon, to the 110-volt A.C. house current.

Electric welder's goggles should be worn to protect your eyes from the arc's glare.



The bowl and lid are made of kaolin, fire clay, and sand. The connections are made directly to the pipes

PORTABLE EASEL FITS BACK OF CHAIR



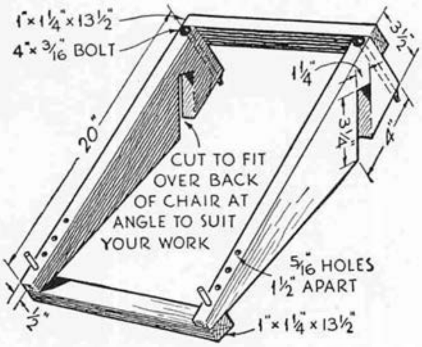
The easel holds a drawing board at a convenient height, with clearance for one's knees

ALTHOUGH light in weight and simple to construct, this easily made portable easel will support the ordinary work of any amateur artist or draftsman. It is merely hooked over the upper back rail of any ordinary chair. There is nothing underneath to get in the way of the knees, and the easel takes up almost no room when not in use because it can be hung on the wall.

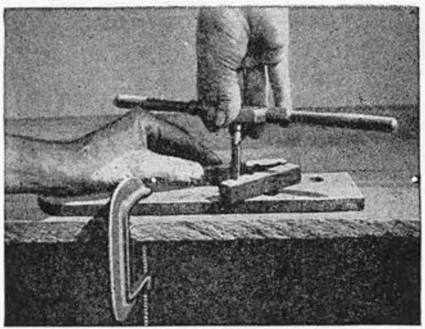
The sides are cut from 1 by 3½-in. stock; the other two pieces are what is known as "blind stop" or 1 by 1¼-in. material. Fasten the frame together with nails or screws. For adjusting the height of the work, drill four or five 5/16-in. holes 1½ in. apart and make pegs to fit.

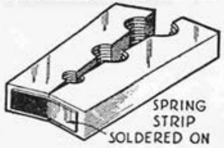
If the lumber at hand is strong hardwood that does not split easily, it is not necessary to reënforce the slots that fit over the back of the chair, but if you are using pine or other softwood, drill a ¼-in. hole in each side just above the "dap" and insert a 4 by 3/16-in. bolt. This will prevent splitting when pressure is exerted.

The width may have to be varied to suit the chair you intend to use, but the suggested dimensions apply to most wooden chairs.



How the framework is made. The reënforcing bolts are necessary only if the wood is soft

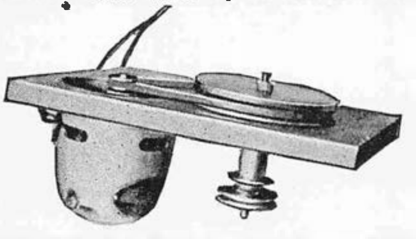




This tap guide, being in two parts, can be clamped directly around the tap, thus saving considerable time

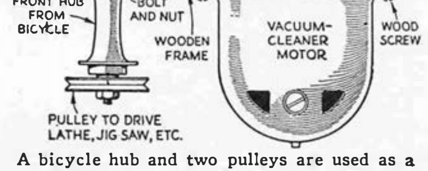
TWO-PIECE GUIDE HELPS IN STARTING A TAP

IT IS good shop practice to make use of a guide for starting a tap vertically in a drilled hole, and the ordinary guide consists of a metal block with a tapped hole through it. This serves the purpose adequately, but it necessitates the extra work of running the tap through the guide before beginning the job and removing it when the work is finished. An improvement is to make the block in two parts. Simply clamp the two pieces in the vise, then drill and tap the guide holes; do not make the holes and saw the block afterward. A strip of spring metal soldered to the ends of the two halves, as shown in the drawing, adds to the convenience of handling them.



VACUUM-CLEANER MOTOR ADAPTED FOR SHOP USE

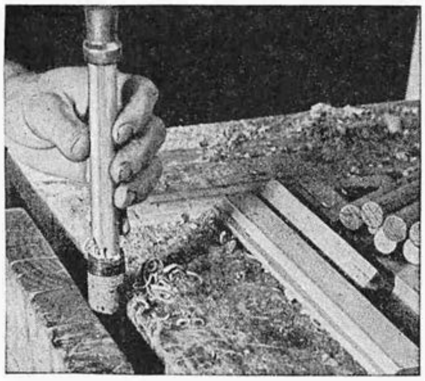
VACUUM-CLEANER motors are comparatively easy to obtain second hand, but because of their high speed (8,000-10,000 r.p.m.) are not suitable for driving most home workshop machinery without some form of speed reduction. The illustrations show how a countershaft may be added to the motor, making it a compact power unit to be used in place of a regular ¼ h.-p. motor. The basis is a bicycle front hub, on the axle of which are mounted a large and a small pulley, one at each end. The motor and countershaft are then arranged on a suitable wooden board. The belt may be a round leather one, but a rubber vacuum-cleaner belt will give better results.

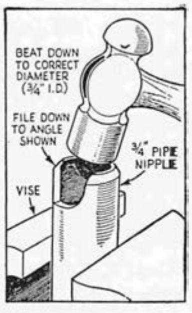


A bicycle hub and two pulleys are used as a speed reduction unit with the discarded motor

DOWELS SHAPED WITH SHARPENED PIPE

SCRAPS of wood can be made into dowels of any desired size with a tool formed from a pipe nipple or short piece of pipe. In the case illustrated, ¾-in. dowels were needed, so a pipe of approximately ¾-in. inside diameter was used. File one end of the nipple to the angle shown in the sketch, hammer in the filed edge until it measures exactly the desired size, and grip the pipe vertically in the vise. Rip short lengths of stock for the dowels to ¾ in. square, or whatever size is wanted, and then dress off the corners to form an octagon shape. If the wood is hard, plane off the eight corners to make the stock more nearly round before driving it through.

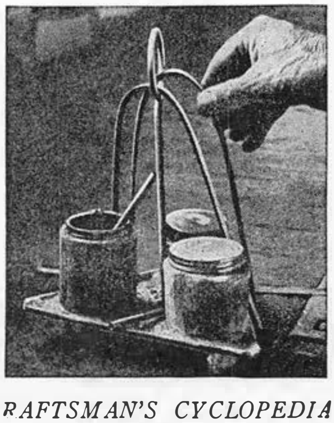




The dowel-making tool and, at left, how the rough stock is driven through

LEAD-COVERED TRAY HOLDS JARS OF SOLDERING ACID

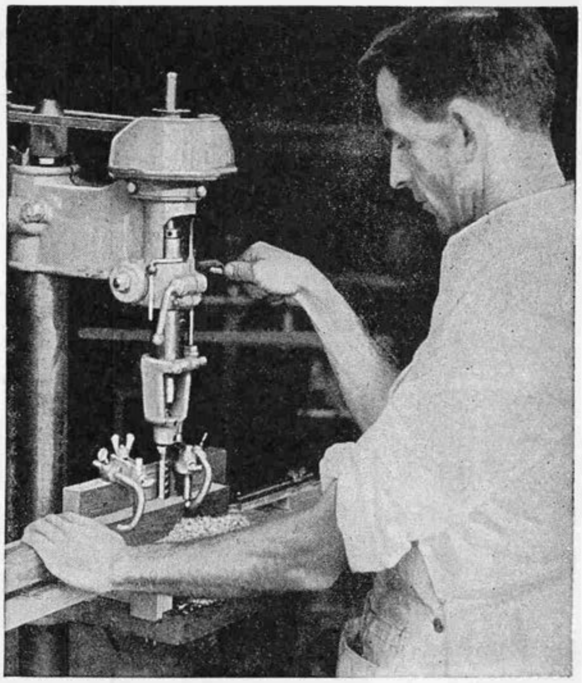
A METAL tray covered with sheet lead and holding three small mayonnaise jars makes a convenient acid tray for the shop. It can be made in various ways to suit one's convenience and the work to be done, but the holder illustrated at the right is of triangular shape and rests on three legs of scrap metal. A short rod with a loop in the top serves as the handle. Thin sticks of solder may be carried by bending them as shown.

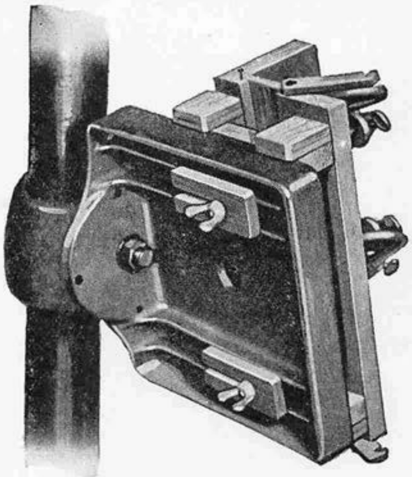


Soldering acid, which is dangerous if spilled, can be carried safely about a shop in small mayonnaise jars. The tray is made acid-proof with sheet lead

Reversible Mortising Jig

Saves Time and Insures Accuracy





Once the jig has been correctly set, it is necessary only to start mortising and move the piece as far as it will go. At the left is shown how the jig is clamped on. Note the end stops for centering the device on the drill-press table. To remove the jig, the wing nuts are loosened and the two long wooden "washers" slipped out of place, freeing the whole

HERE is a simple jig for drill-press mortising that makes it unnecessary to do any laying out on the work, and absolute accuracy is assured in cutting, since stops automatically locate the mortise and limit their length. Furthermore, the stop slide can be instantly reversed for mortising pairs of legs, without changing the setup in any way.

The jig base is a piece of 1 by 6-in. lumber screwed to the regular fence supplied with the machine. Counterbore the clamp-bolt holes to sink the heads flush. The two cleats beneath the base have notches, which act as runs for the stop slide. Before screwing them on, groove the underside of the base to allow passage of the tail stop and its clamp screw when mounted on the slide. Space the cleats from outside to outside equal to the table width, with the same base projection at each end. This is very important. Nail or screw to each cleat a plywood stop projecting ¼ in. below, to catch the table edges, thus centering the jig as it is put on the drill-press table.

The slide is a piece of dressed 1 by 2-in. wood of any convenient length. Screw a fixed stop to one end, using a cardboard shim between the pieces to raise the top of the stop a little above the jig base. Make a movable head stop as shown to clamp on top of the fixed stop. A similar but smaller forked plywood strip serves as a tail stop.

Make two plywood dogs or catches to pivot on the jig ends, as in the drawing, notching the ends to clasp over nails driven into the jig.

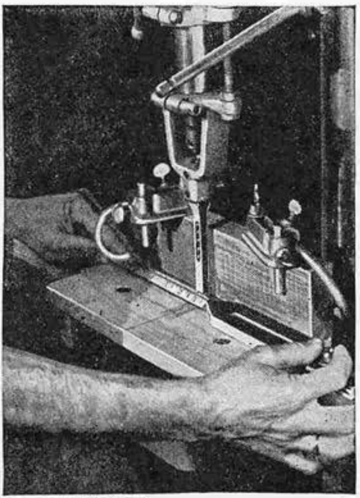
To help in centering the jig on the mortising chisel, square a center line out from the fence on the base, and draw lines each side, as shown below, to indicate where the sides of chisels of various sizes come.

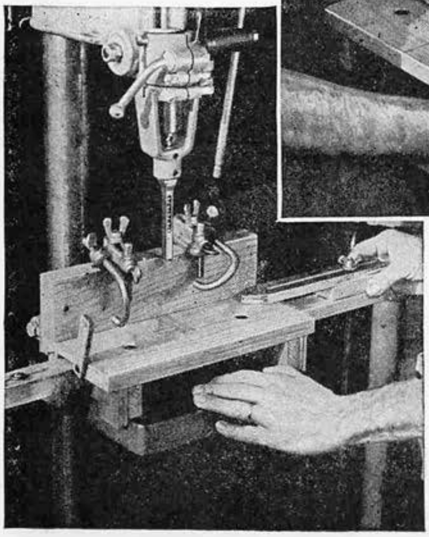
Place the jig on the table, slip the forked "washers" between the bottom of the table and the wing nuts, lower the chisel, and swivel the table to center the jig. Next, slide the jig forward or backward until the distance from the chisel to the fence equals the distance of the mortise from the face side of the work. Lift the stop dogs, insert the slide from the right end, drop the dogs, and push the fixed head stop against its dog. Holding the slide, move the head stop until the end is as far from the chisel as the mortise is to be from the end of the work, and clamp it with the wing nut. Finally, adjust the tail stop the same distance from its dog as the length of the mortise is to be.

Lay the piece to be mortised on the jig, one face down and the other against the fence. After adjusting the hold-downs, press the end of the piece against the stop and move it, together with the slide, to the left until the fixed stop prevents further motion. Start mortising and move the piece until the tail stop engages, when the job is done.

If additional mating pieces for the other end of a frame are to be mortised, finish the first, lift the dogs, and reverse the slide, using the head stop against the left end of the jig. This allows the face sides to bear against the base and fence again. Of course, if table legs are being mortised, everything will be gone over with the slide reversed.

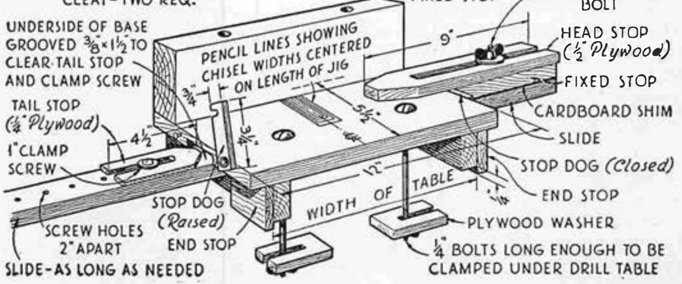
If the legs are of the cabriole type, or have turned portions larger than the square sections, block the squares up with strips of wood. Then proceed as previously described.



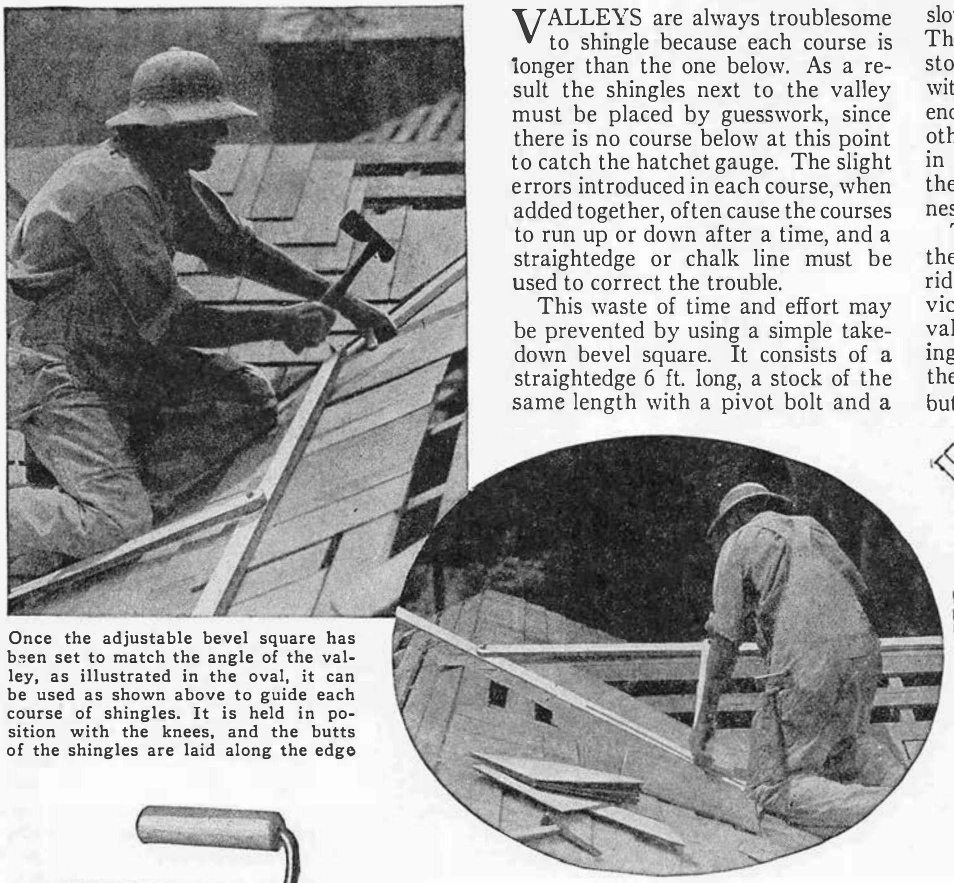


The head stop is adjusted the same distance from the chisel as the mortise is to be from the end of the leg or any other work

By lifting each of the dogs or catches as at left, the slide can be reversed to mortise matching pieces. The drawings give details



Take-down Bevel Square Aids in Shingling Valleys

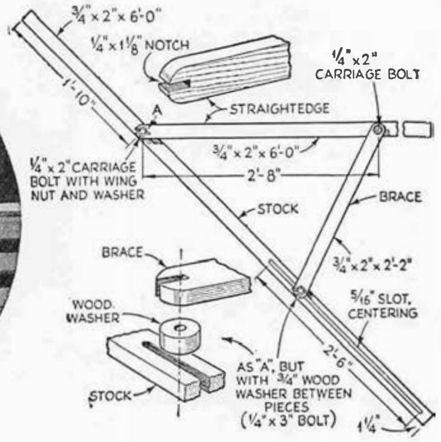


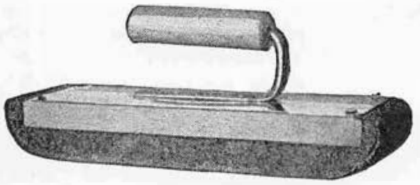
Once the adjustable bevel square has been set to match the angle of the valley, as illustrated in the oval, it can be used as shown above to guide each course of shingles. It is held in position with the knees, and the butts of the shingles are laid along the edge

VALLEYS are always troublesome to shingle because each course is longer than the one below. As a result the shingles next to the valley must be placed by guesswork, since there is no course below at this point to catch the hatchet gauge. The slight errors introduced in each course, when added together, often cause the courses to run up or down after a time, and a straightedge or chalk line must be used to correct the trouble.

This waste of time and effort may be prevented by using a simple take-down bevel square. It consists of a straightedge 6 ft. long, a stock of the same length with a pivot bolt and a slot in which a bolt slides, and a brace. The end of the straightedge pivots on the stock and is notched for quick removal without taking out the bolt. One brace end is bolted to the straightedge, while the other is notched to clasp the sliding bolt in the stock. A wooden washer between the brace and stock make up for the thickness of the straightedge.

To use, lay the stock in the valley near the top, adjust the straightedge along the ridge, and tighten the wing nuts. The device can then be laid at any point in the valley and held with the knee while checking the courses, drawing a pencil line along the straightedge, or resting the shingle butts against it.





A SOFT SANDING BLOCK FOR CURVED SURFACES

DIFFICULTY is sometimes experienced in eliminating all edge marks when sanding curved surfaces. Many cabinetmakers use a piece of cork as a sandpaper block, but unless the surface is nearly flat, even this is often too hard. An efficient sander for this purpose is shown above.

Obtain a plasterer's rectangular trowel, drill a screw hole in each corner, and cut a ½-in. piece of pine to the face dimensions of the metal. Slice an ordinary rubber kneeling pad lengthwise down the center, place both pieces on the wood, and tack the ends to the ends of the block. The metal of the trowel is then bent slightly convex and screwed to the wood. The ends of the sandpaper are gripped between the wood and metal.

DIVIDERS USED TO MARK PLANKS ON MODELS

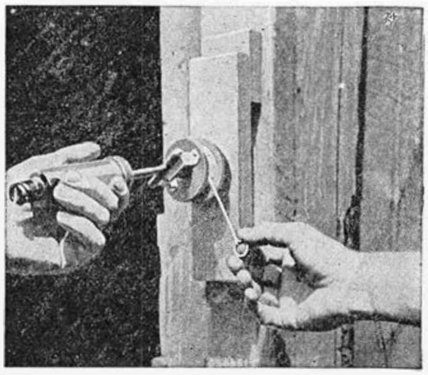
INSTEAD of using a flexible straightedge for marking hull planks on ship models. You will find that a pair of dividers suit the purpose better. First set the dividers to the width of a plank and, holding one leg on top of the bulwarks, mark the first plank. For the second plank set the dividers to twice the width and so on. The lines of planking stop, of course, at the copper line. If the cap rail has been put on, an allowance must be made for that in marking the first plank.

PULL ON CORD UNSCREWS GREASE GUN

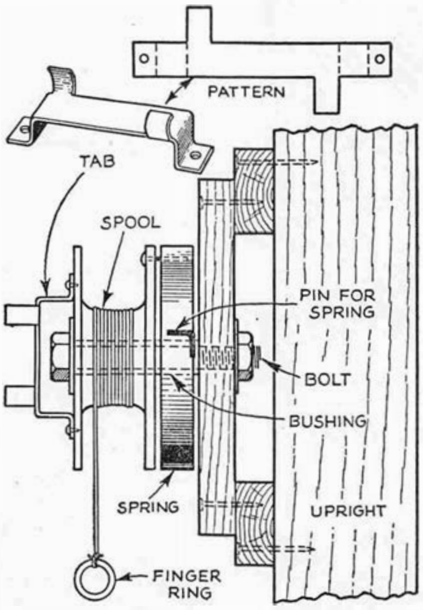
IN DOING an automobile grease job with the usual type of pressure gun much time is wasted in turning back the screw plunger so that a fresh charge of grease may be put into the barrel. To save this unnecessary delay, a simple device can be made to run it back quickly.

A long machine bolt with a bushing slipped over it is mounted on a simple wooden frame, which is then fastened to the wall near the grease rack. A small metal or wooden spool and a spiral spring, taken from an old clock, are slipped over the bushing. To the outside of the spool is attached a piece of sheet metal shaped as shown, with tabs bent over to engage the handle of the grease gun. The inside end of the spring is fastened to a right-angled pin that is threaded or soldered in a small hole through the bushing and bolt, and the outside end is attached to another pin protruding from the side of the spool. A length of stout cord is fastened inside the spool and wrapped several times around it.

To unscrew the plunger, put the handle in place against the spool and pull the cord, which completely runs out the screw. By removing the gun and releasing the cord, the spring, which tightens as the cord is pulled, will wind up the cord ready for use again.



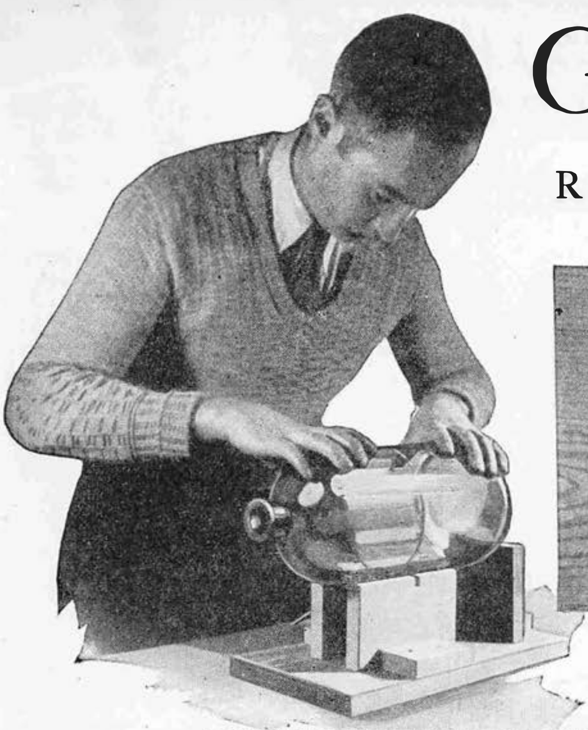
The grease-gun plunger is run back for a new charge by giving the cord a single long pull

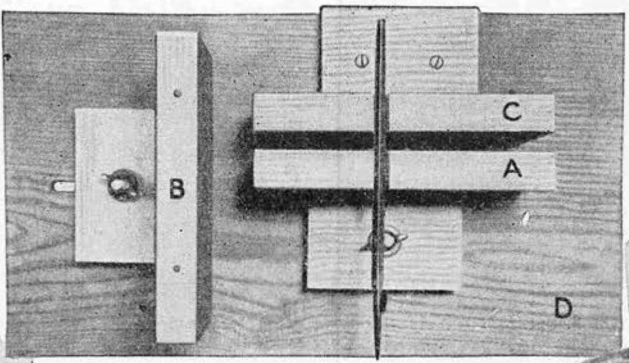


How the spool, clock spring, and tabs are assembled, and a pattern and sketch of the tabs

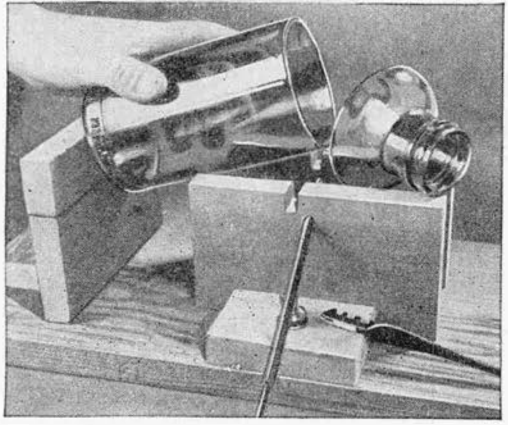
Glass-Cutting Jig

REMOVES TOPS FROM BOTTLES





A top view of the jig with three-cornered file in place across the cradle for cutting a bottle as shown in the photo at the extreme left



How a bottle is rolled on a file is shown above. The position of the cut is fixed by the backstop, which may be adjusted back and forth. A lightweight bottle is cut by rotating it in the cradle in contact with the broken end of a file held as shown at right

The cutting of a heavy bottle is completed by heating it with a string soaked in alcohol and lowering it in cold water

WITH this simple glass-cutting jig, you can remove the tops from bottles in order to make vases, flowerpots, chemical flasks, and any number of other containers.

The wooden base *D* is 8 by 15 in. On it are mounted two uprights *A* and *C*, 3/4 by 3 1/2 by 6 in., which form a cradle. The back stop *B* is 3/4 by 4 1/2 by 6 in. The small blocks attached to these three parts are about 2 1/4 by 3 1/2 in. Upright *A* and backstop *B* are adjustable by means of bolts fitted in slots cut in the baseboard.

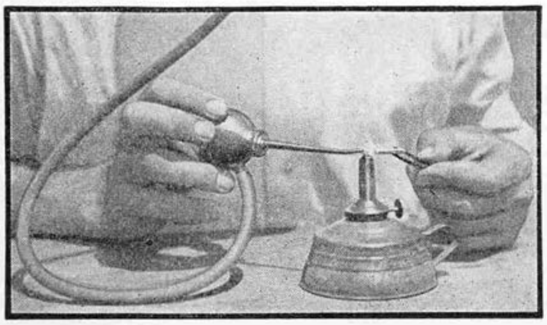
Slots are provided in *A* and *C* to receive a three-cornered file, and *A* is also drilled at the angle illustrated in another of the photographs to take either a file or a glass cutter.

A lightweight bottle can be cut merely by rotating it in the cradle in contact with a file that has been broken off short to provide a sharp edge. For glass tubing, place the uprights close together and use the file lying across them. After this treatment, bottles having thin side walls will snap apart cleanly and evenly with a light tap.

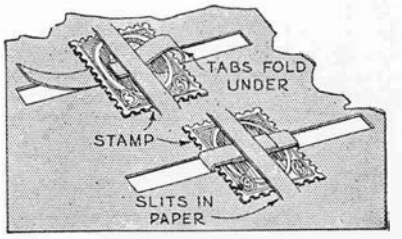
Rather than chance breaking heavier bottles or small square bottles with thick corners, wrap them twice with soft string at the file mark and soak the string with a few drops of alcohol. Light the string and, when the alcohol has burned away, quickly remove the string and slowly lower the bottle, mouth up, in a container of cold water. It will separate into two parts with an audible snap.

SMALL BLOWPIPE MADE FROM OILCAN

A BLOWPIPE is essential in chemical analysis and in testing minerals for fusibility and other reactions. An efficient one can be made from a small five-cent oilcan, a length of rubber tubing, and a valve stem from an old inner tube. Select an oilcan which has a spout with a very small round hole. In one side of the oil reservoir, drill a small hole and solder a section of the valve stem over it to form a connection for the rubber tubing.



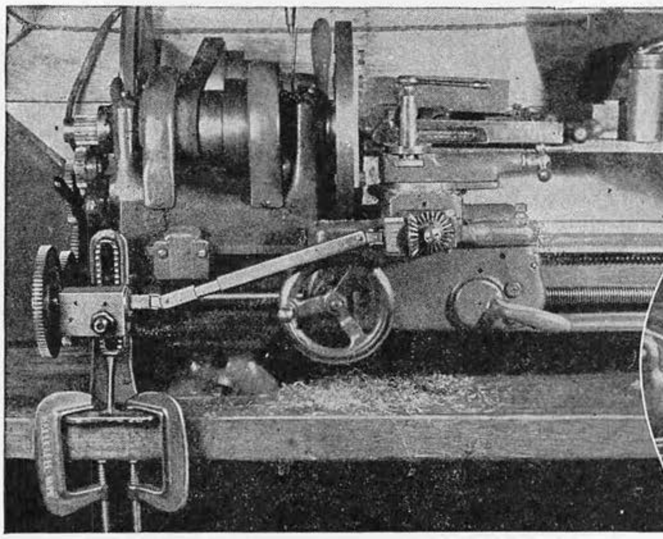
The reservoir of the can forms a receptacle for collecting the condensed moisture from the breath, as in the better commercial blowpipes. In addition, the operator's face need not be held near the burner, and no heat from the flame can be accidentally conducted to the lips.

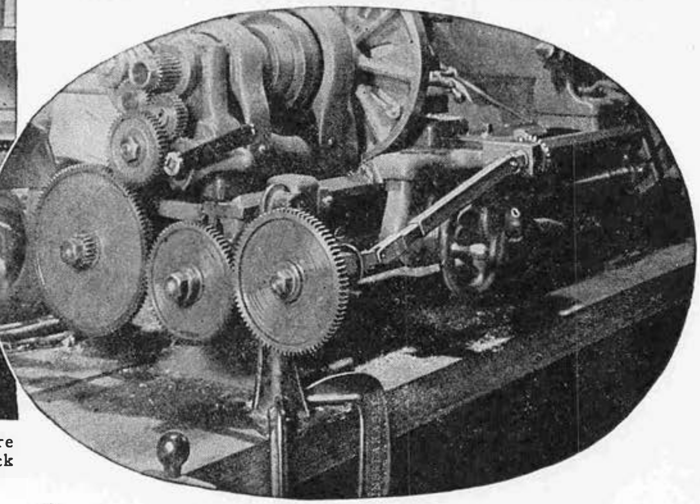


NEAT WAY TO INCLOSE STAMPS WITH LETTER

WHEN inclosing stamps in an envelope, you may attach them safely and neatly to your letter by the method illustrated above. This prevents any possibility of the stamps being lost or removed by some unauthorized person without the knowledge of the recipient.

Geared Cross Feed for Small Lathes





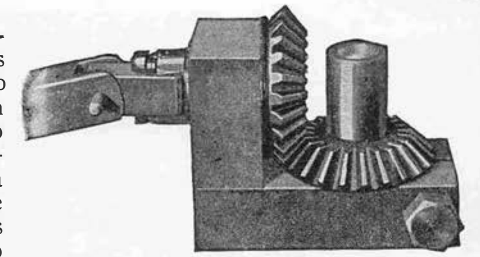
General view of the entire mechanism. Universal joints made from square tubing enable cross feed to be moved to and from the faceplate or chuck

MOST small metal lathes are not manufactured with gear-driven cross feeds, but when the inevitable job turns up that requires such a feed, the problem can be solved very easily by means of two small miter gears, 8 or 10 in. of ½ by ½-in. square (inside) steel tubing, and a square rod to slide within the tubing. The necessary bracket, shafting, and clamps are to be found around most shops, so need not be purchased.

The illustrations are self-explanatory. First remove the handle from the cross feed and turn a sleeve from steel shafting to fit the cross-feed shaft. Machine the miter gear and shaft to a forced fit and attach to the shaft.

The second miter gear is held in mesh by means of a right-angle bracket made of cold rolled steel 1¼ by 7/8 in. The length will be determined by the size of the miter gears. The bracket is held in position by slotting and clamping it upon the bearing extension of the cross feed as shown. A half turn of the hexagonal bolt will hold it securely.

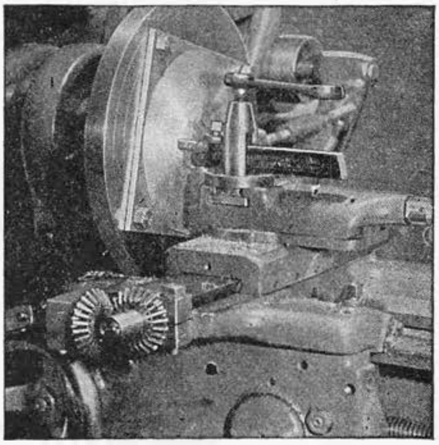
The gears are brought into proper mesh by means of fiber washers. Power from the gear train to the cross feed is obtained by the square steel rod, which slides into the square steel tubing. It will be necessary to file the corners of the shaft to get a running fit. Universal joints enable the cross feed to be moved to and from the faceplate or chuck. They are made from the square steel tubing and rod as shown.



One miter gear fits over the sleeve on the cross-feed shaft while the other is held in mesh by means of a right-angle steel bracket clamped on the cross-feed bearing extension

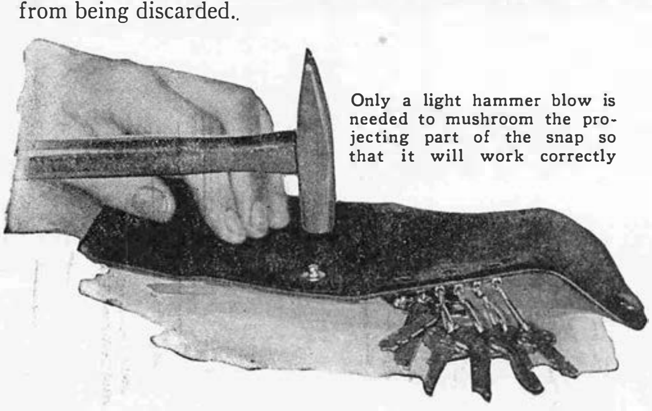
If the universal joints are made with taper-pin bearings, there will be no lost motion and no loss whatsoever in precision of the cross feed.

The cross-feed drive gear is held in mesh with the usual lathe gear train by a shaft passing through a piece of steel or hardwood and supported by a bracket clamped to the bench as shown. By using extra gears and a little ingenuity, a wide variety of feeds across the faceplate can be obtained. Not only is the cross-feed adapter simple to make, attach, or remove, but it also serves for a variety of work that is ordinarily done on lathes costing many times the price of the smaller types with which home mechanics have to be content.

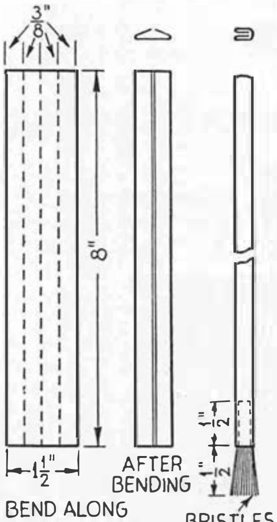


REPAIRING LOOSE KEY-CASE SNAP

WHEN a key-case snap becomes loose through long wear, it may be repaired by mushrooming the projecting part with a light hammer blow. This will expand the part so it will fit the socket tightly. If it is accidentally flattened too much, squeezing with pliers will bring it back into shape. Many valuable leather articles fitted with snaps of this type can thus be saved from being discarded.



Only a light hammer blow is needed to mushroom the projecting part of the snap so that it will work correctly



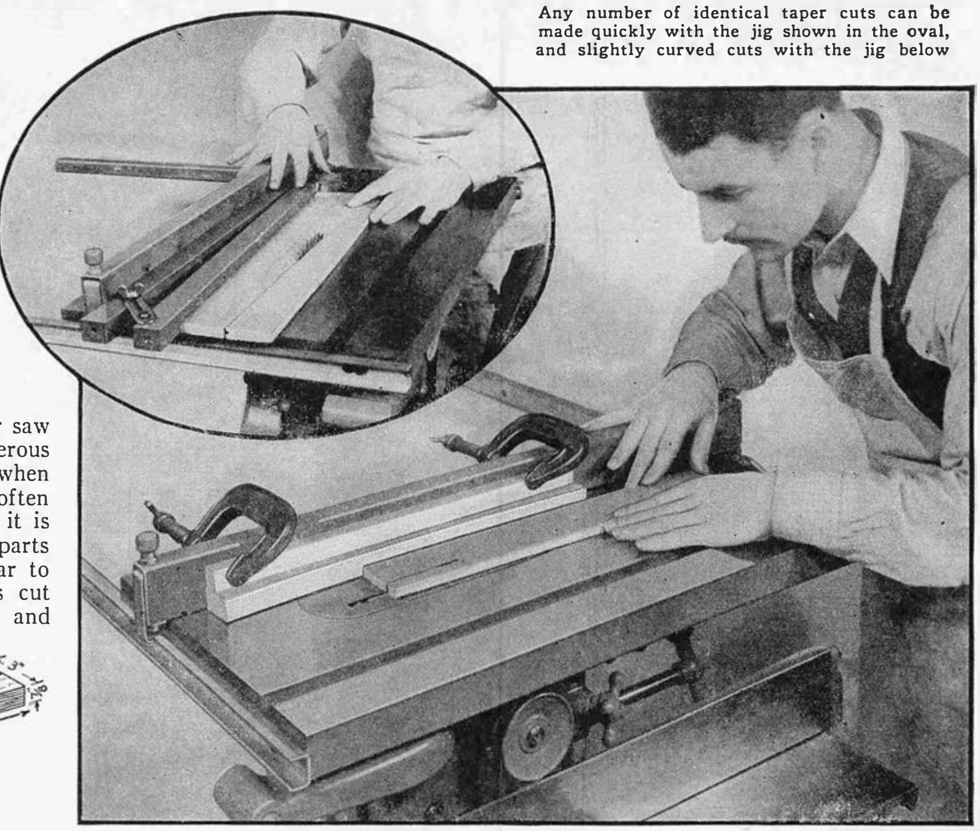
How the tin is cut and bent to grip the bristles securely

SMALL BRUSHES MADE FROM OLD BROOM

A QUANTITY of small brushes for applying glue, shellac, soldering flux, and rubber cement or for cleaning delicate mechanisms may be made from an old brush-type broom with a fair quality of bristles and a few scraps of tin or light sheet metal.

Cut a number of tin strips as shown and scribe lines ⅜ in. apart. Bend the metal along the two outside lines over a piece of 1/16-in. scrap iron. Then bend along the center line to make a V when viewed from the end. Cut a tuft of bristles at least 1 in. long and insert in each side of the V, crimping the metal with pliers just enough to hold the bristles firmly. Close the handle along its entire length with pliers; then hammer it straight with light blows and trim the bristles.

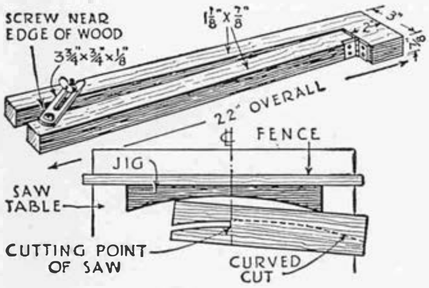
Jigs Simplify Cutting Tapers and Curves on a Circular Saw



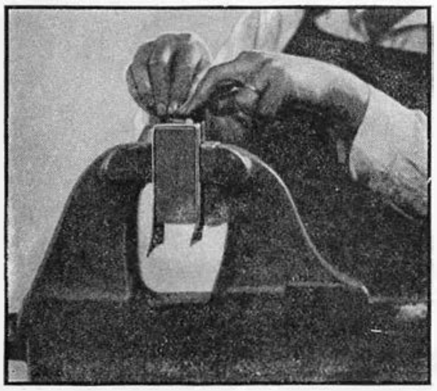
Any number of identical taper cuts can be made quickly with the jig shown in the oval, and slightly curved cuts with the jig below

ACCURATE taper cuts on the circular saw can be easily made by using the jig shown in smaller of the accompanying photographs and also in a perspective sketch below. This allows tapers from zero to 2 in. in 20 in. to be cut, or equivalent tapers in shorter or longer stock. The two legs are hinged together at one end and have an adjustment in the form of a slotted piece of strap iron at the other. A wing nut locks the movable leg at the desired angle. The control could be indexed, if desired, so that the taper could be set to any degree without measuring.

Extreme curves cut on the circular saw can be made only by running numerous cuts tangent to the desired line, but when the curve is slight or "slow," as it is often called, and the stock itself is light, it is possible to shape as many duplicate parts as are required by using a jig similar to the second one shown. The jig is cut out carefully to the desired curve and mounted on the saw table in such a way that it is held squarely against the fence and exactly central with the center of the saw blade. The saw must barely come through the wood, and it should be sharp and have a good set in order to insure success in production work of this kind. The jig does not move; it simply furnishes the two contact points for the work as it is pushed through. This is made clear in the lower of the two drawings at the left.



Adjustable jig for tapered cuts and diagram showing how slightly curving cuts are made



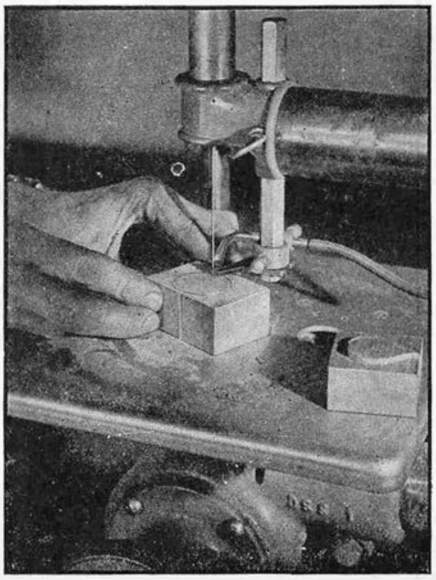
HOLDING SANDPAPER AND EMERY CLOTH IN VISE

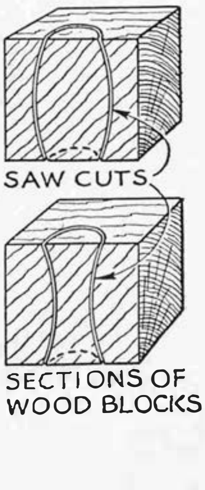
THE usual plan of folding a sheet of emery or sandpaper around a block cannot conveniently be used where the piece to be smoothed is too small to be held in a vise or against a bench stop. It is much easier to hold the abrasive in the vise as shown above and move the work across it by hand. Fold the abrasive paper or cloth over a wood block as usual, clamp the combination in the vise, and then use two hammers to strike simultaneously upward against both ends of the block. The abrasive will cling to the vise jaws, and the block move upward within it until the emery or sandpaper is taut.

MYSTIFYING BLOCKS CUT ON JIG SAW

EVERY user of a spring-type jig saw who has tried to cut thick hardwood with an extremely fine blade has discovered that it is difficult, if not impossible, to make the blade travel in a straight up-and-down line. In a 1 in. thick piece of oak or other hardwood, the thin blade may bow out as much as ⅛ in. By taking advantage of this action, you can make a novelty that will baffle your friends. They will not be able to guess how you managed to make it.

Simply insert a fine jeweler's or jigsaw puzzle blade into your machine, and cut a circle or other shape in a thick block of hardwood. You can start the cut from one edge, or drill a small hole through which to insert the blade. The first arrangement will be found the better because the blade can be removed more easily after the cut. Usually the cut starts in a straight line and ends in a curved form, which makes completion a bit difficult. Operate the saw at slow speed. The plug will be shaped either like a barrel or a spool, and this effectively prevents its removal from the block. You may have to try several pieces of wood before you find one having the right hardness or grain structure to produce exactly the results that are desired.

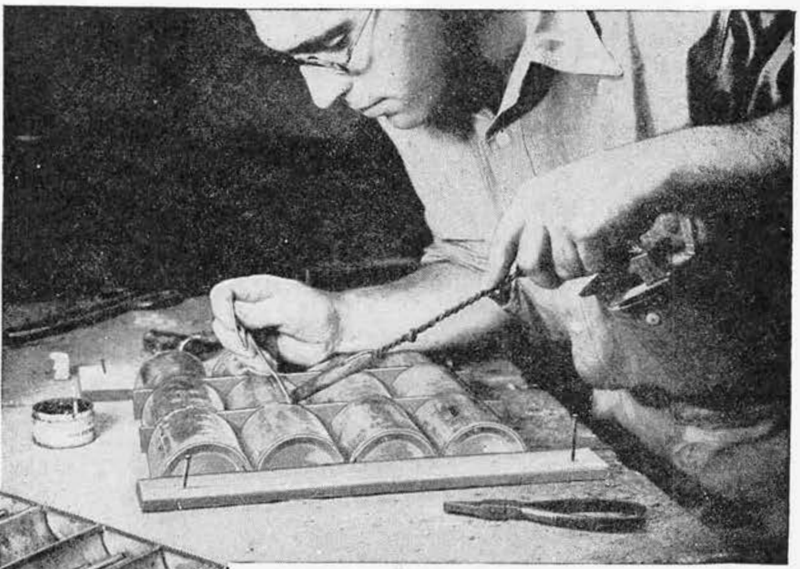




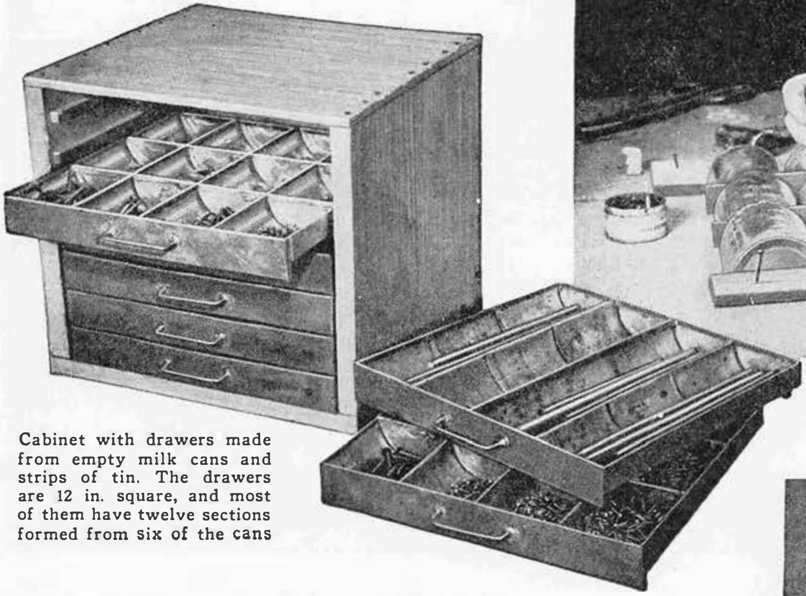
Cutting the blocks on a scroll saw and, at right, how they would look if sliced in two

Handy Hardware Drawers

ASSEMBLED FROM MILK CANS



After the cans have been cut open across each end and down one side, they are folded to form twin compartments, arranged with tin strips between and soldered together



Cabinet with drawers made from empty milk cans and strips of tin. The drawers are 12 in. square, and most of them have twelve sections formed from six of the cans

COMPACT, handy drawers with individual sections for sorting and storing bolts, screws, and other small parts can be made in a short time as illustrated from empty evaporated milk cans and a few strips of tin. Because of the rounded shape of these sections, pieces kept in them will slide to the center, where they can be picked up easily.

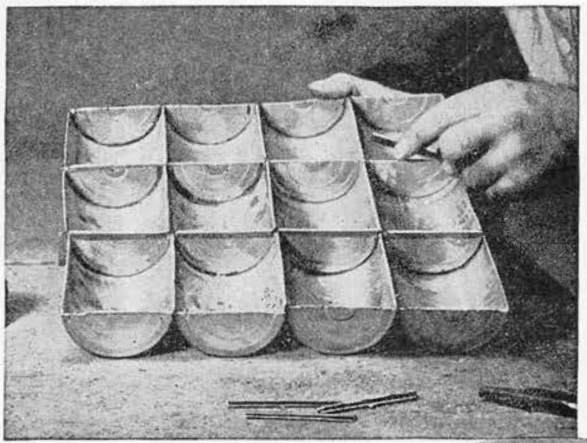
The cans are cut open across each end and down one side, and folded back on the remaining side to form twin compartments. They are then placed upside down on a bench or table as they are to be in the finished drawer, with a strip of tin between the ends of each row of cans, and soldered together and to the tin strips. The drawer thus formed is turned over, and the edges of the cans, where they form the partitions, are covered with bent strips of tin. The sides of the drawer are finished with wider strips of tin, which are bent over the cans and soldered as shown.

Note that the sides of the drawers are narrower than the front and back. This leaves a recess for the wooden runs on which the drawers slide.

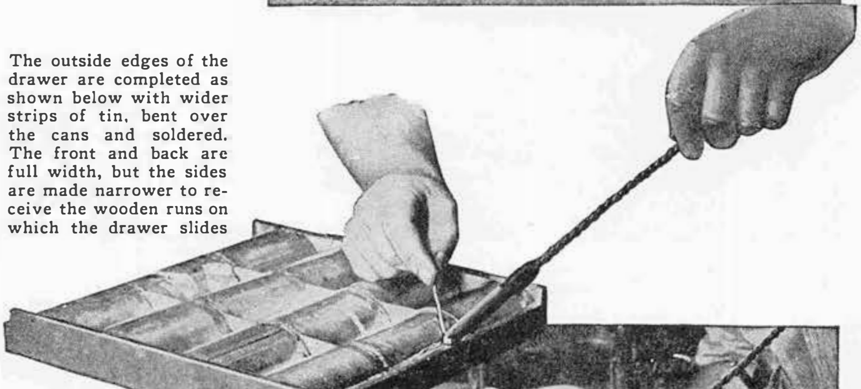
For a handle, a piece of heavy wire is bent to shape and soldered into holes punched in the front of the drawer.

Drawers with longer compartments for rods, pieces of tubing, and the like can be made by removing both ends of the cans that form the inside sections, and one end of each of the outside cans. All are then soldered together. The sections are next formed into drawers by cutting slots about $\frac{1}{4}$ in. deep across the bottom of each row of cans, and soldering doubled strips of tin in the slots as shown at the right. These drawers are finished like those previously described.

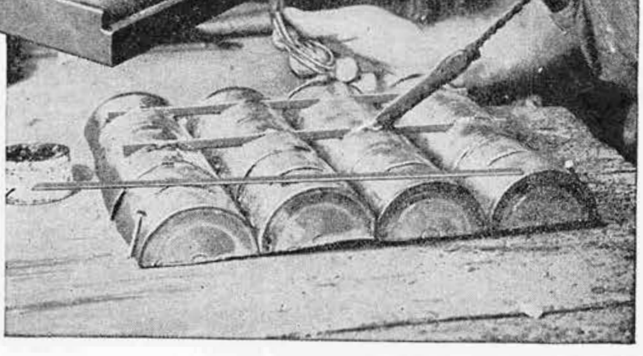
The drawers can be made any size desired. Those illustrated are approximately 12 in. square, and most of them have twelve compartments (formed from six cans).



The drawer is now turned right side up, and the edges of the cans, where they come together and form partitions, are covered with bent strips of tin. The drawer shown contains six cans, which make up the twelve small, round-bottomed pockets



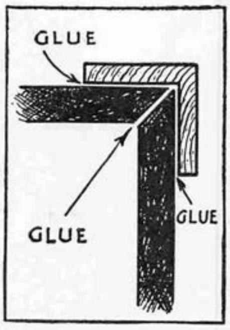
The outside edges of the drawer are completed as shown below with wider strips of tin, bent over the cans and soldered. The front and back are full width, but the sides are made narrower to receive the wooden runs on which the drawer slides



A drawer with longer compartments is made by removing one end from each of the outside cans and both ends from the cans that form the inner sections. After these are soldered, the drawer is reënforced with doubled strips of tin set into slots cut across the cans

Strong Corner Joints *for* THIN STOCK

An easy way to make light, neat-looking boxes, cabinets, and instrument cases

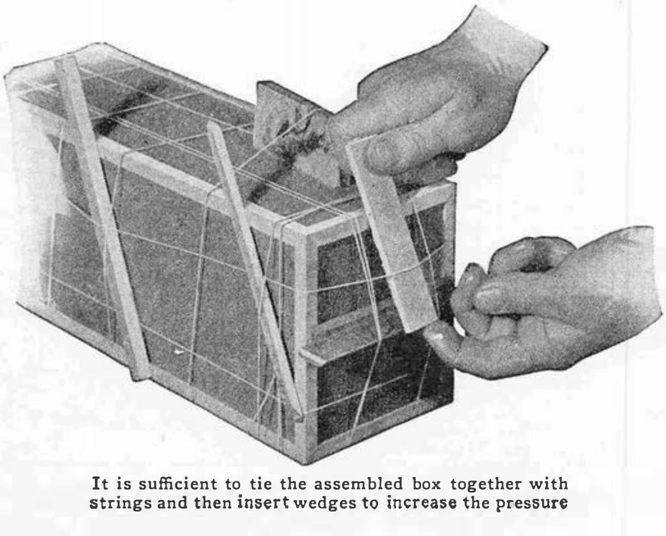


An unusually strong, light case made of thin pressed wood composition. The joints are formed as in the diagram

THE amateur woodworker soon finds that corner joints of the tongue-and-groove, dado, or rabbet types are exceedingly difficult if attempted with thin stock. Furthermore, the remarkably strong and warpless panels made of pressed wood fiber, which are now used for so many purposes, are not adapted for such joints. The joint illustrated is better when thin wood, plywood, or pressed fiber panels are to be used in making boxes.

All cutting is done with a circular saw, no dado head is required, and no clamps are needed in the gluing operation. The L-shaped locking strip is only ⅜ in. on each leg, and the legs are only 3/32 in. thick. The panels are of ⅛-in. pressed wood fiber. When pressure is applied to a joint like this, the edges of the panel are forced together and the outer edge surfaces of the panels are forced against the inner surfaces of the locking strip.

Making the locking strips is most easily done by ripping the wood into squares and then setting the saw and rip guide so that passing the piece through twice will remove the core to give the L-form. Incidentally, the portion removed is a perfect square and can be saved for model making or other purposes.

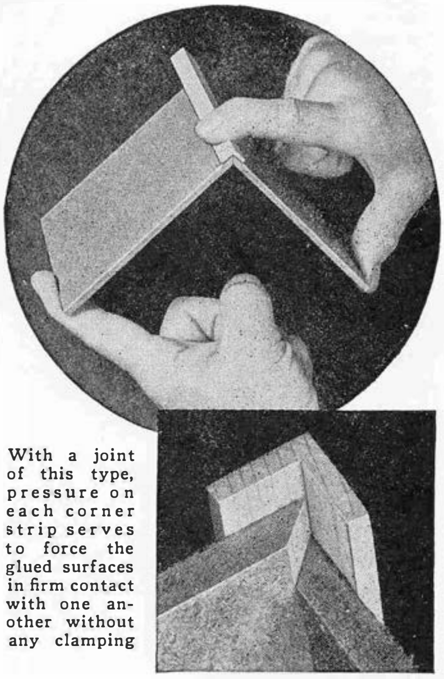


It is sufficient to tie the assembled box together with strings and then insert wedges to increase the pressure

The edges of all panels are cut to a 45-deg. bevel. The squared-up dimensions of the panels before the beveling operation will be exactly the same as the finished outside dimensions of the box, which, of course, will be the inside dimension plus twice the thickness of the panel material.

Only three settings of the saw and rip guide are needed to bevel all panel edges. The guide should be set so that the saw barely clears the edge forming the point of the angle; then this line will form a guide when the panel is turned around to cut the opposite edge. All beveling is on the same side of each panel.

Twelve lengths of locking strip have to be cut, four for each of three different dimensions. Their lengths will be equal to the outside dimensions of the box or cabinet plus twice the thickness of one leg of the locking strip. The ends of the locking strips are cut to 45 deg. on each leg of both ends with the aid of the cross cut guide set for this angle. The cuts should be taken so that the saw just barely clears the end which is thus formed.



With a joint of this type, pressure on each corner strip serves to force the glued surfaces in firm contact with one another without any clamping

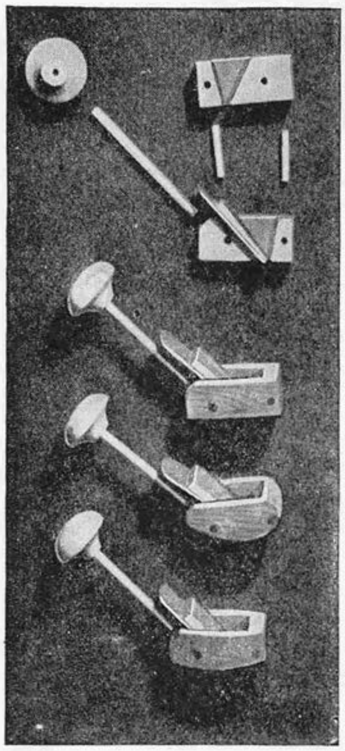
To assemble a box constructed in this way is easy if you first lay out four pieces of string across the bench tit-tat-to fashion. Then lay the locking strips for one side on these strings with tacks behind them to hold them into rectangular contact. Apply glue to the strips and to the edges of the panel and drop it into place. Next, after gluing, set the other panels on edge to form a square resting on the first panel as a base. The tackiness of the glue will hold their edges together long enough to allow you to apply the remaining side panel and the corresponding four locking strips. Now bring the ends of the four strings up over the top and tie.

From there on it is merely a matter of applying the four remaining locking strips, tying with string and wedging the strings tight. The lid is sawed off afterwards.

Tiny Thumb Planes

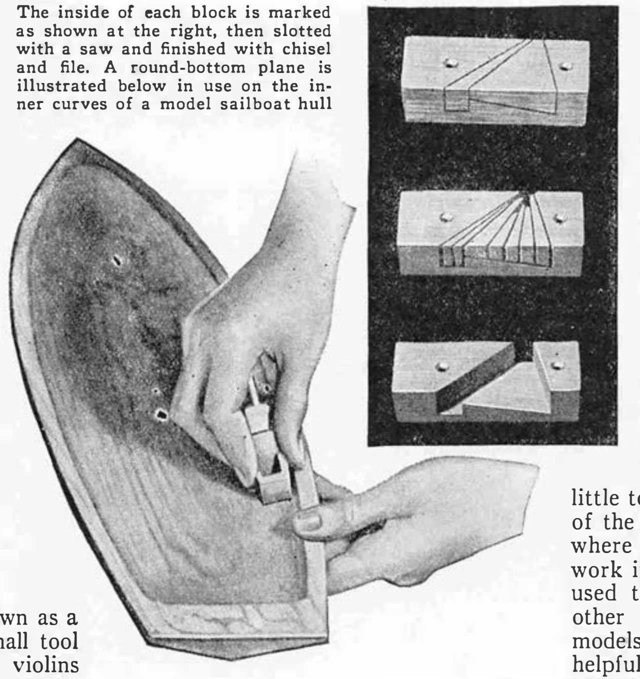
AID IN BUILDING MODELS

You can make a whole set for a few cents and will find them invaluable for shaping hulls and similar work



The parts of a thumb plane ready for assembly, and three complete planes with bottoms of different shapes. The body of each plane is made in halves, then doweled

The inside of each block is marked as shown at the right, then slotted with a saw and finished with chisel and file. A round-bottom plane is illustrated below in use on the inner curves of a model sailboat hull



WHAT is familiarly known as a "thumb plane" is a small tool invaluable in making violins and similar musical instruments and in shaping model ships, airplanes, sailing yachts, and the like.

The body of this plane is held between the thumb and forefinger, and the handle butts against the palm of the hand. With the ordinary plane of this type, the fingers get tired very quickly, but with the new design illustrated, it is possible to work for several hours without undue fatigue or cramps in the fingers because a good deal of the thrust required to push the plane is taken up by the carefully designed palm rest.

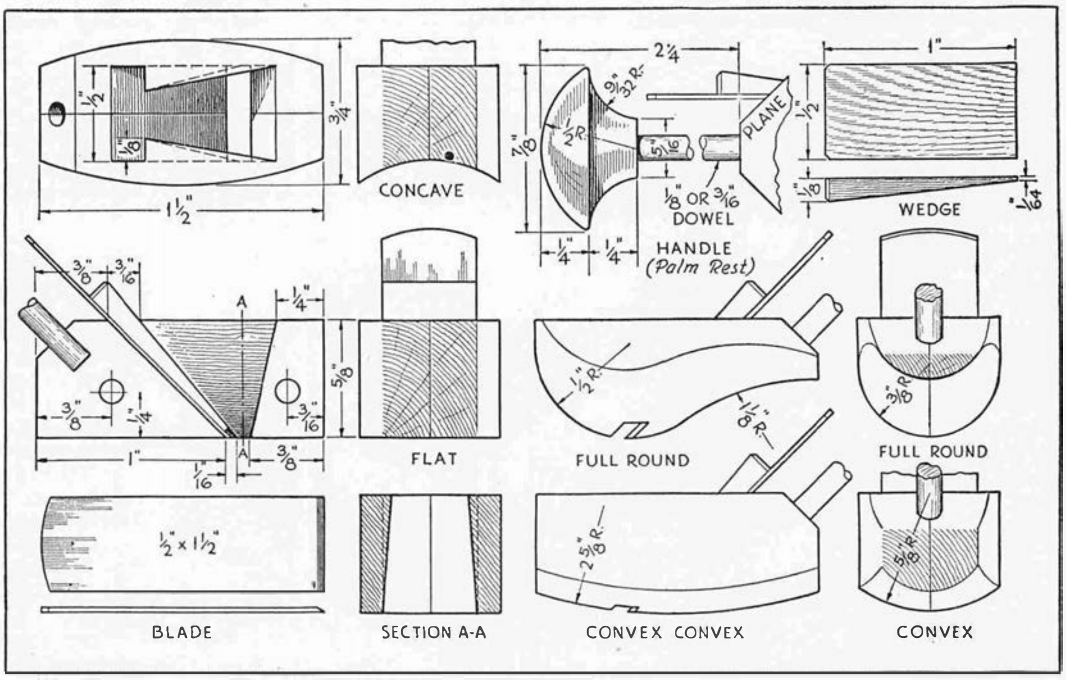
The body of the plane is made of two pieces of maple, beech, or some other hardwood with a fine, close grain. Each piece should be ⅜ by ⅝ by 1½ in. Clamp them together and drill two ⅛-in. dowel holes as shown in the drawing. With the dowels in place, mark the top and bottom of the pieces; then remove the dowels and mark the inside of both pieces. With a small saw, chisel, and file, remove the waste wood.

When you have finished shaping the inside, the two parts should be doweled and glued together. After the glue has set, the sides can be finished, and then the bottom of the plane can be shaped as you desire—straight, concave, convex, or in any other form.

A palm rest turned to the shape and size shown in the drawing is to be preferred; however, a serviceable rest may be made from a slice of ⅞-in. dowel with the top rounded, and a hole drilled in the bottom to take a ⅛- or 3/16-in. dowel. The wedge is made of hardwood as indicated.

The blade is a piece of hack saw or similar steel, ground and honed to the shape of the bottom of the plane. In setting the plane, let the blade project just a hair from the bottom.

Although the utility of these little tools is more or less obvious, a few of the many jobs may well be mentioned where they will be found to do better work in less time. The flat plane can be used to shape decks, deck houses, and other small parts necessary in making models. The convex or full round is most helpful in shaping the flare at the bow of ship models, also for shaping the inside of ship and sailing models. The concave plane has been found just the tool for shaping masts and yards; it does the work neatly and makes it much easier.

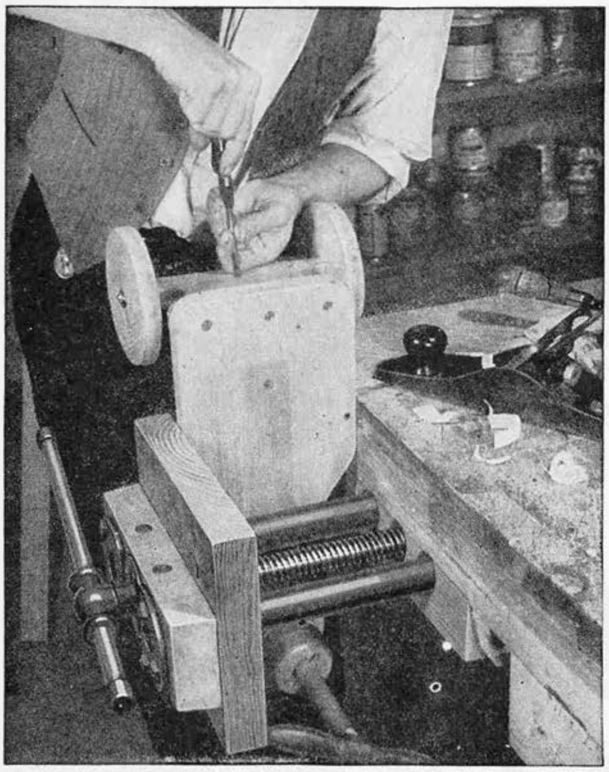


Full-size drawings of thumb planes to show the method of construction and various shapes found useful for models

Heavy-Duty Woodworking Vise

Runs Smoothly on Guides

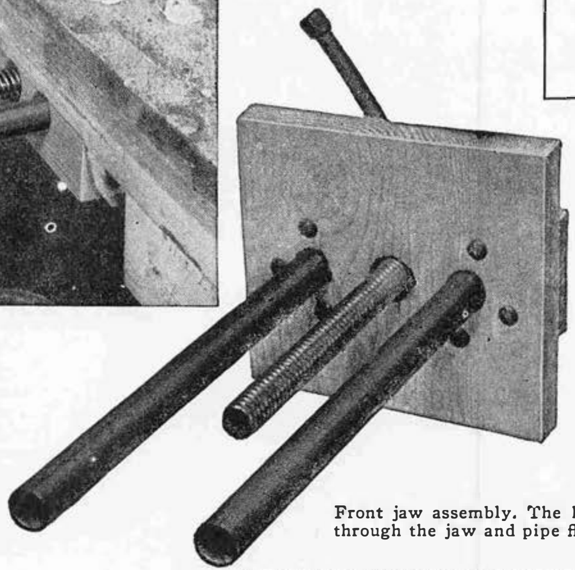
MADE FROM PIPE



The homemade vise in use. Note its large capacity and how the jaw remains rigidly parallel to the edge of the thick bench top. If desired, a stationary jaw may be added

List of Materials

- 1 iron bench screw, size 1¼ in., with square thread for approximately 12 in. of its length.
- 2 pc. pipe, 1 in. inside diameter and 20 in. long, threaded at one end of each.
- 2 pipe flanges to fit above.
- 1 pc. oak or maple 1⅝ by 12 by 10 in. for front jaw.
- 1 pc. oak or maple 1⅝ by 4 by 12 in. for jaw batten.
- 6 carriage bolts 4 by 5/16 in., to be used in front jaw.
- 2 pc. pipe, 1¼ in. inside diameter and 12 in. long, for guide sleeves.
- 4 lag screws 5 by 5/16 in. for sleeve assembly.
- 2 pc. 2½ by 2½ by 12 in. hardwood for cross members of sleeve assembly.



Front jaw assembly. The heads of the bolts which pass through the jaw and pipe flanges are sunk into the wood

MANY woodworking vises of home construction are inefficient. This is due, in the main, to their ill-devised guides, or to their complete want of them.

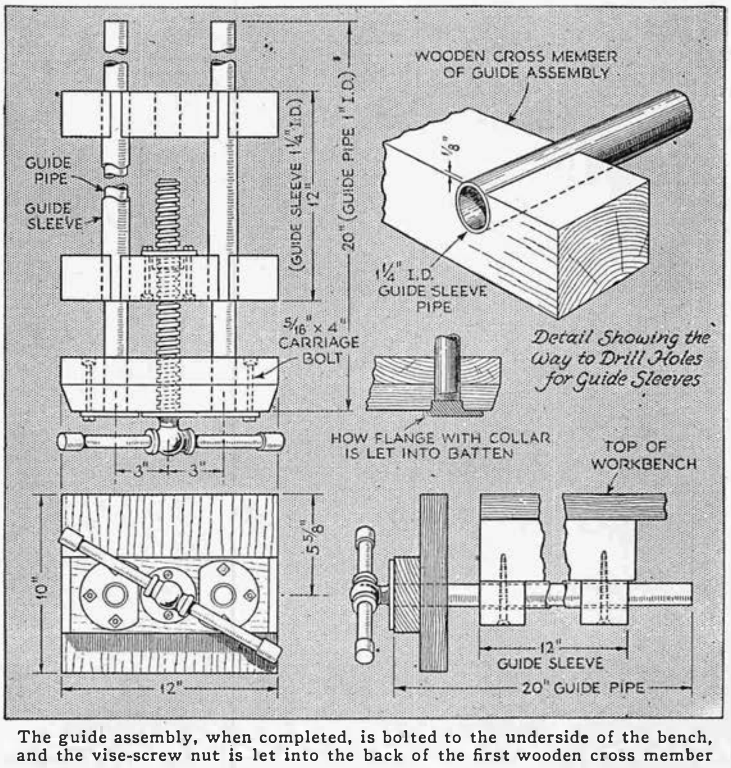
In the vise illustrated, two sizes of ordinary plumbing pipe are used to form a guide system that is extremely rigid, yet free working. No machining is necessary provided the plumber, after he cuts your pipe, threads one end each of two pieces. The jaws open to approximately 9 in. and provide a working depth of about 4 in. Light metal and sheet-metal work may be done by temporarily laying a piece of angle iron over each jaw. The vise can be made at a cost of about three dollars for materials.

Hardwood should be used in the construction. The illustrations show fir serving as the front jaw of the original model, but this will be replaced when necessary with oak or maple. The grain of the wood in the jaw should run vertically.

After cutting the jaw and the reënforcing batten, fasten them temporarily together (bolts will later hold them securely); then mark the centers for the two guide-pipe holes and the bench-screw hole. The former should be drilled for a snug fit; the latter, large enough to allow the bench screw to work freely.

The two pipe flanges require a segment to be hacksawed out as shown in the drawing. After this has been done, they are each turned tightly on the threaded ends of the guide pipes. Should the flanges have a collar around the threaded hole, place them so that the collar will have to be let into the batten in order to keep as much hand room between the vise handle and the jaw as you can. Mark the location of the holes in the flanges on the batten and drill through batten and jaw for the carriage bolts. Countersink the boltheads on the inner side of the jaw; and after tightening the nuts well, cut the bolts off flush with the nuts. This completes the front jaw assembly except for putting the bench screw in place and fastening it with two wood screws, but this is better left to the last in order to simplify aligning the various parts.

The guide-sleeve assembly, which is fastened to the underside of the bench, offers no difficulty other than demanding accuracy in its making. The holes for the guide sleeves in the two cross members must be carefully located and drilled. These holes may either be bored close to the edge and then the top edge dressed down, or drilled so that the hole cuts the top


GUIDE PIPE
GUIDE SLEEVE
(GUIDE SLEEVE 1¼" I.D.) 12"
20" (GUIDE PIPE 1" I.D.)
5/16" × 4" CARRIAGE BOLT
3"
3"
10"
5⅝"
12"
WOODEN CROSS MEMBER OF GUIDE ASSEMBLY
⅛"
1¼" I.D. GUIDE SLEEVE PIPE
Detail Showing the Way to Drill Holes for Guide Sleeves
HOW FLANGE WITH COLLAR IS LET INTO BATTEN
TOP OF WORKBENCH
12" GUIDE SLEEVE
20" GUIDE PIPE

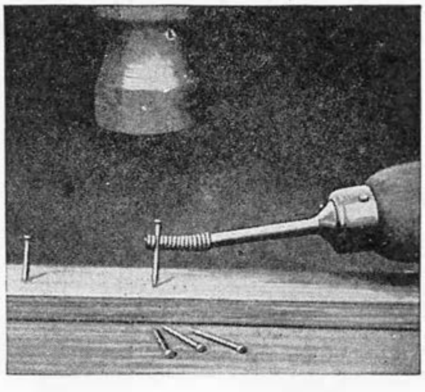
The guide assembly, when completed, is bolted to the underside of the bench, and the vise-screw nut is let into the back of the first wooden cross member surface of the cross member for the length of the hole (see the detail drawing of the cross member). The holes are bored in this manner so that the guide sleeve will be clamped tightly between the cross members and the bench top when the assembly is lag screwed in place.

The bench top on the bench shown is 4 in. thick, but as the reader's will probably be thinner, it will have to be built down to the thickness shown in the drawing. This may be done with short odds and ends, fastened securely with screws and glue, as the vise will exert quite a pull upon this section.

The bench-screw nut is let into the back of the front member and secured with wood screws or bolts.

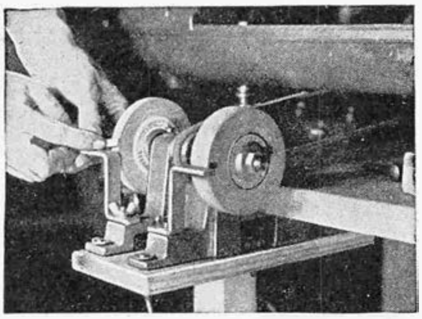
When the guide-sleeve assembly has been lag screwed to the bench, insert the guides of the front jaw into the sleeves; engage the bench screw and bring the jaw up tight to the bench. The flange on the bench screw may now be secured, and any slight difference in level of jaw and bench top dressed off.

SPRING HOLDER AIDS IN DRIVING SMALL BRADS



SMALL nails and brads are difficult to hold when starting into the wood. A simple device not only to hold, but also to pick them up, is shown above. Force one end of an ordinary tire valve core spring on an awl or any other pointed tool. Pressing the spring down picks up the nails.

GRINDER MOUNTED UNDER BENCH TO SAVE SPACE

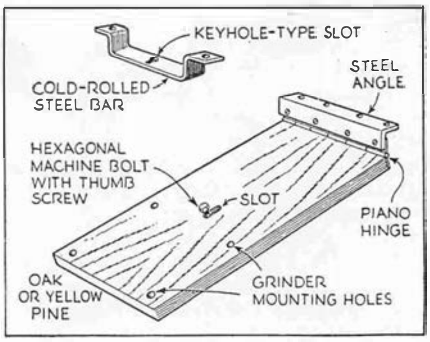


The tool grinder raised to operating position in front of a bench that holds a lathe

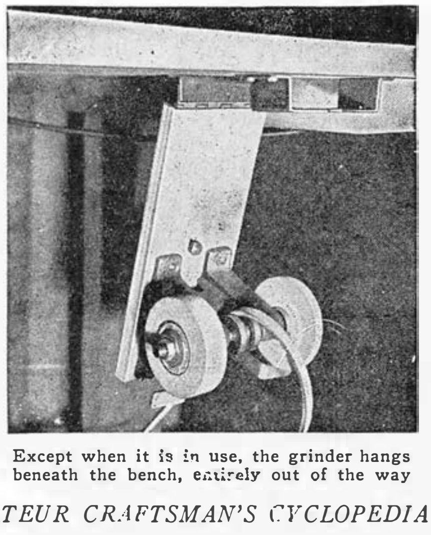
MOUNTED on a sturdy base that swings under the workbench when not in use, this grinder is always handy, yet takes up no bench space. By locating this accessory in line with a motor used for some other piece of equipment, the need for a countershaft or extra motor is eliminated.

Fasten a steel angle under the bench to support the hinged baseboard at one end. At the outer edge of the bench, underneath the top, mount a strap steel stand-off brace to hold the grinder horizontal and to provide a seat for the clamping bolt. The latter is an ordinary hexagonal machine bolt with a large wing nut. The head of the bolt must just pass through the large part of a keyhole type slot in the stand-off brace, and the threaded portion must just clear a straight slot in the baseboard.

Use a large washer between the wing nut and the underside of the baseboard. It is also a good plan to use an extra belt, leaving it on the grinder at all times.



The mounting consists of a hinged baseboard and a brace to hold it in the raised position



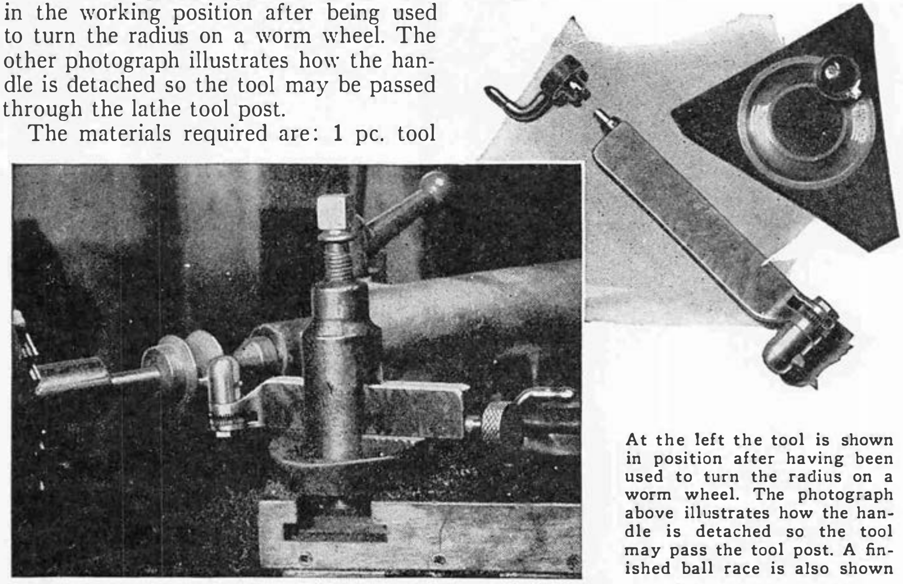
Except when it is in use, the grinder hangs beneath the bench, entirely out of the way

ADJUSTABLE TOOL FOR TURNING RADII

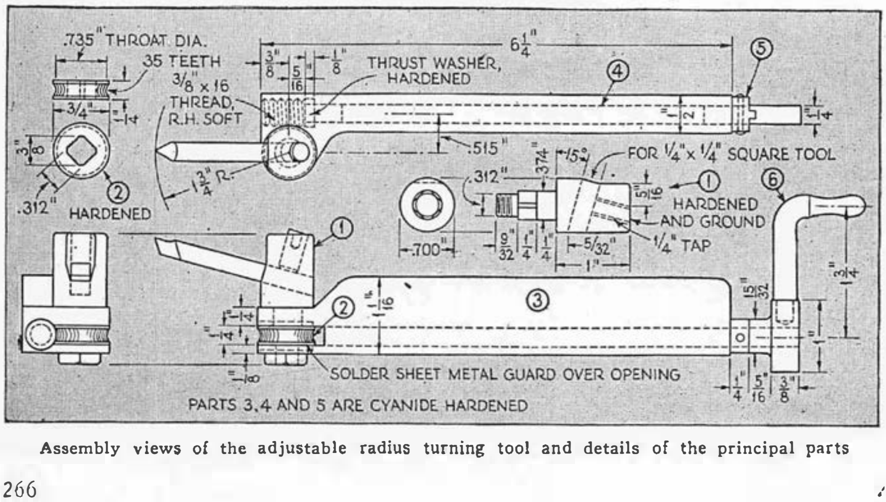
THE adjustable radius turning tool illustrated below turns radii from ⅜ to 1¾ in. The tool bit in the revolving head is moved by means of the handle at the other end. The bit is set to the required radius by measuring with micrometers from the tip to the back of the holder.

The large photograph shows the tool in the working position after being used to turn the radius on a worm wheel. The other photograph illustrates how the handle is detached so the tool may be passed through the lathe tool post.

The materials required are: 1 pc. tool steel .700 in. diameter by 1 25/32 in. for the part marked *1;* 1 pc. tool steel ¾ in. diameter by ¼ in. long for part 2; 1 pc. cold-rolled steel 1 1/16 by 1 25/64 by 6¼ for 3; 1 pc. cold-rolled steel ⅜ in. diameter by 7 3/16 in. for 4; and 1 pc. cold-rolled steel 15/32 in. diameter by 11/32 for 5.



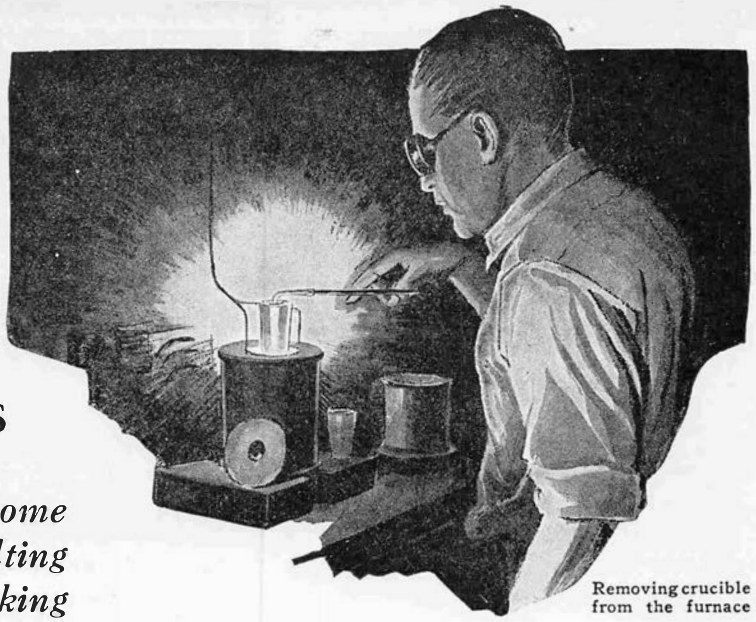
At the left the tool is shown in position after having been used to turn the radius on a worm wheel. The photograph above illustrates how the handle is detached so the tool may pass the tool post. A finished ball race is also shown



Assembly views of the adjustable radius turning tool and details of the principal parts

Electric Furnace

MADE FOR TWO DOLLARS



Removing crucible from the furnace

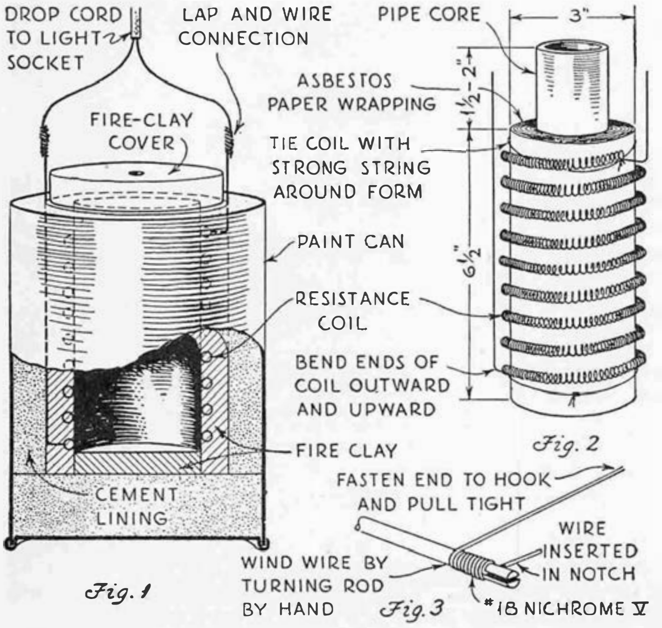
It serves many purposes in the home workshop . . . Can be used for melting metals, brazing, tempering, and baking

A SUBSTANTIAL electric furnace for melting metals, heat treating, brazing, glassmaking and many other uses can be made by the home mechanic for less than two dollars. Various types and sizes can be made; but a good general utility furnace, going to about 1,800 deg. F. on 700 watts, will have a heating chamber about 3 in. in diameter by 6 in. deep. It will take a 2½-in. diameter fire-clay crucible and will melt two or three pounds of metal.

Obtain a tin can at least 6 in. in diameter by 8 in. deep. If a paint can is to be used, scrape off or burn out every trace of paint.

A good material for the outer lining is a mixture of equal parts of Portland cement and asbestos pulp. This latter is a dry white powdery material that can be bought in bulk for a few cents a pound at most large hardware stores and furnace repair shops. About five pounds of each will be needed. If, however, the asbestos pulp is not obtainable locally, an equal quantity of fine sand may be substituted, although sand is not so good. The ingredients should be mixed dry. Knead out all lumps and continue mixing until the powder is uniform in color throughout. Then add water a little at a time and knead until the cement is a moist, crumby mass, but not so wet that water can be squeezed out of it in the hand. Ram a layer 1½ in. deep into the bottom of the can with a heavy stick or iron bar, using considerable force. This layer is a solid support for the form to be used in making the cylindrical part of the lining (Fig. 1).

THE form, 4½ in. in diameter by about 8 in. long, must be made collapsible so that it can be drawn out after the lining has been molded. A piece of pipe or tubing, or an old bottle, 3½ or 4 in. in diameter, tightly wrapped with asbestos paper to build it up to the required size, will serve the purpose. The asbestos paper can be held in place with a few turns of friction tape. Most large hardware stores sell asbestos paper for a few cents a square yard.



Cut-away view of the furnace and method of winding the resistance coil

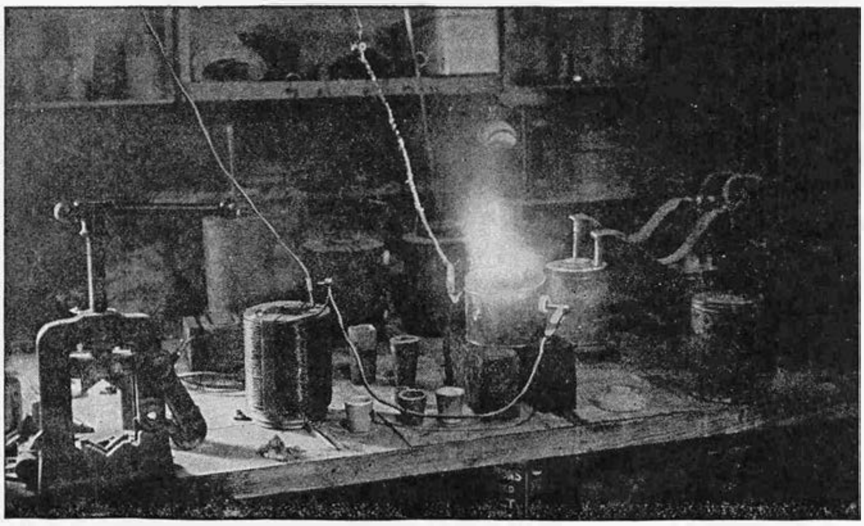
The form, which should be made before the cement is moistened, is set upright in the center of the can, on the rammed-in bottom. The cement then is rammed in around the form as compactly as possible. Take care to ram equally on all sides of the form so that it is not crowded away from the center. To obtain uniform compactness and heat insulation, the cement should be put in by layers, 1 in. or less deep. Ram in each layer thoroughly before adding the next. The lining is built flush with the top of the can and may be finished off with a putty knife or trowel. For finishing, have the cement a little more moist. The core is then pulled from the form, and the asbestos paper torn out.

Give this first lining about a day to set before molding the inner lining. It must be kept moist while setting. The setting may be hastened, if desired, by painting the surface with a coat of water glass diluted with an equal volume of water. Undiluted water glass is too thick to penetrate the pores of the cement.

The furnace is now ready for the inner lining, into which the electric resistance is molded. This resistance should consist of 40 ft. of No. 18 nichrome V wire or 36 ft. of ordinary No. 18 nichrome wire. The former is better because it oxidizes much more slowly and has a much longer life. A smaller, shorter wire having the same resistance could be used, but it would not last nearly so long. The wire must be coiled on a ¼-in. round rod about 2 ft. long. If a back-geared lathe is not handy, this coil may be made by mounting a breast drill in a vise, clamping the rod in the drill chuck, and turning the crank with one hand while feeding the wire onto the rod with the other. It also can be made by cutting a notch in the end of the rod with a hack saw (Fig. 3), slipping the end of the wire into it, and turning the rod with the hands while winding the wire upon it. The wire must be kept tightly stretched to make a close coil.

ABOUT 8 in. of wire at one end and 2 in. at the other must be left straight. The coil is slipped off the rod and stretched out about 6 ft. Take care that the stretching is everywhere uniform, and that all the turns are equally spaced. The coil must now be wound on the form for the inner lining.

This inner form, like that for the outer lining, may be made of asbestos paper wrapped on a pipe core so as to have a diameter of 3 in. and a length of 8 in. (Fig. 2). The long end of the resistance coil is fastened ½ in. from the bottom of the form by looping a strong string around it and tying the ends around the form, as shown. The coil is then wrapped tightly around the form in a spiral of about seven



An electric furnace being used in a home workshop. The nichrome furnace is in the background

turns, ⅝ in. apart, center to center. The upper end of the coil is fastened in the same way. The straight ends are bent outward and upward as shown, and the form with the coil on it is set into the furnace on the cement bottom and in the exact center.

If the work has been done properly, the wire ends will project about 2 in. above the top of the can. They should be in contact with the outer lining, or as far from the inner form as possible. The form is now ready for molding the inner lining.

Several more or less costly high-temperature molding cements are on the market, but a good substitute may be made by pulverizing an old fire brick with a hammer on a cement floor and screening about 2 lb. of it through a piece of window screening, then mixing the screenings with 1 lb. of dry powdered fire clay. Some back-yard clays are suitable, but many of them will melt in contact with the wires, which are much hotter than the heating chamber itself. It is safer, therefore, to buy fire clay from a brickyard or a local furnaceman.

The mixed fire clay and brick screenings are moistened slowly and kneaded until the mixture sticks together if squeezed in the hand, but is not so wet as to emit water. If too wet, it will crack when baked. Thin layers of it are then rammed in about the form, but care must be used to keep the rammer away from the wire coils so that they are not displaced. The vertical wire must not be disturbed, and, of course, must not touch any of the turns of the coil. If any of the turns of the coil are accidentally moved into contact with each other, the form and clay must be removed and the molding begun again with the coils in their right place.

When the lining has been molded flush with the top, it may be smoothed with a trowel. The form is then removed, and a ½-in. layer of fire clay is rammed into the bottom of the furnace. Any holes or roughnessses left in the surface around the wires should be filled with fire clay, mixed rather wet and pressed in with a putty knife.

The furnace must be dried for several days in a warm room before heat is applied, or steam may form and cause an explosion. After drying, it is well to paint the top, but not the inside, with a coat or two of the diluted water glass to harden it.

A cover 4½ in. in diameter and ¾ in. thick can be molded of the fire-clay mixture in a tin-can cover or any convenient mold. It should be rammed hard. A ½-in. round hole may be punched through its center before it is dry, so that it can be easily lifted off the furnace with a bent wire. After drying thoroughly, it should be painted with two or three coats of the diluted water glass.

The furnace is now ready to be baked. The two ends of a socket cord are connected to the two ends of the coil wire. Lap the wires and wind the joints tightly with a fine copper wire. Solder, of course, is useless because of the heat. The plug is screwed into a light socket, the cover placed on the furnace, and it is left to bake for from three to six hours. Clay does not give up all its moisture until it is well above red heat. Some steam will be emitted, and the furnace will heat slowly the first time. After two or three heats, it may be expected to reach 1,800 deg. in about an hour and a half.

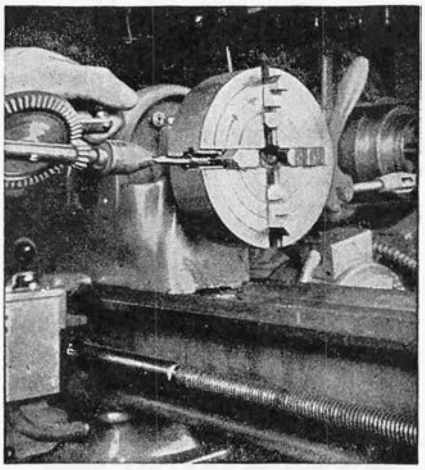
No melted metal of any kind or chemical salts should be allowed to touch the resistance coil. The furnace should be set on a couple of bricks or on a cement floor.

The temperature can be judged by putting small amounts of various materials into iron pipe caps and setting them in the heating chamber. When aluminum melts, the temperature is about 1,210 deg., F. At 1,360 deg., borax melts; at 1,480 deg., table salt. When pure silver melts, the furnace is at about 1,800 deg. A silver coin melts at a slightly lower point. Use the last-mentioned test when heating the furnace the first time, and turn off the current when the coin melts. If the lining is very well made, the furnace may go to a higher temperature, but should not be allowed to do so, for the resistance coil is likely to burn out. If a long heat is wanted at a lower temperature, the cover may be left partly or wholly off.

Because the current used is less than 7 amperes, an ordinary 15-ampere fuse plug is sufficient.

A furnace built as described has been in daily use for more than two years. With a pair of tongs and some fire-clay crucibles that can be bought at a scientific supply store, it is valuable for many purposes. It has been used for melting type metal, white metal, zinc, aluminum, silver solder, brazing metal, yellow brass, bell metal, speculum metal, and other alloys; as well as for brazing, tempering small tools, working and annealing glass, and baking enamel glazes, homemade crucibles, and pottery. Even synthetic rubies, sapphires, and emeralds have been made in this furnace.

TWO LATHE HINTS FOR HOME MACHINISTS



A rod, squared at the end and held in a hand drill, quickly reverses jaws of a lathe chuck

When working with an independent four-jaw lathe chuck, key is satisfactory for tightening and adjusting the jaws, but is very slow and tiresome for reversing them. For quick work, square the end of a 3-in. piece of drill rod, insert it in a hand drill, and use as illustrated above.

Lathe work is always somewhat oily and dirty. If you work from a magazine article and handle the magazine, you are certain to get it badly soiled. To prevent this and preserve magazines in good condition for future reference, keep a large clip hanging on the wall and attach the magazine, open to the article you want, to that.

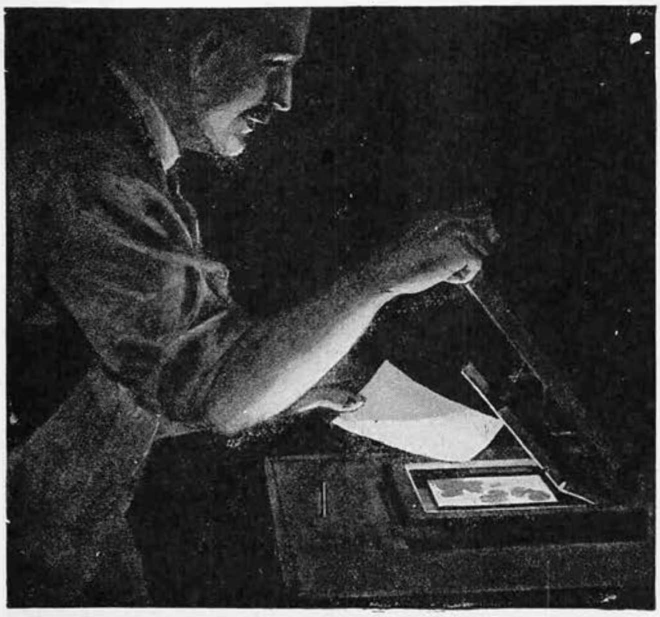
Magazine hung by clip near lathe so that it will not become soiled by constant handling

KEEPING SOLDER CLEAN

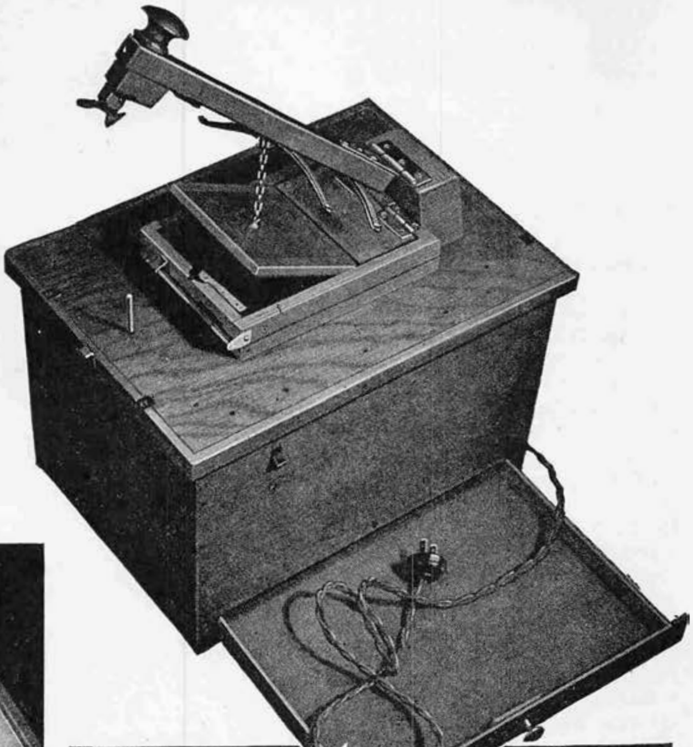
If wire or stick solder has been left lying around and is dirty, you will find that it pays to polish the end with a piece of sandpaper before using it so that no dirt will be deposited at the joint.

Printing Box

Reduces Darkroom Drudgery

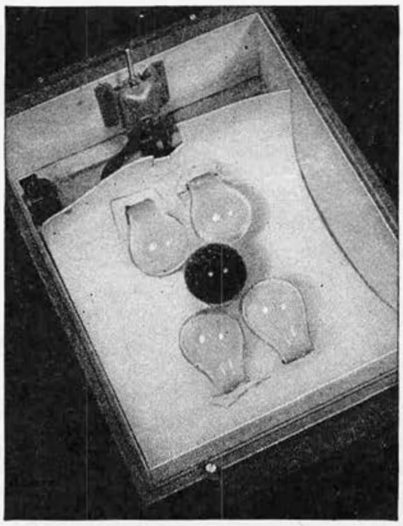


This efficient printer for photographs makes use of a standard automasking printing frame, so the construction work is relatively simple

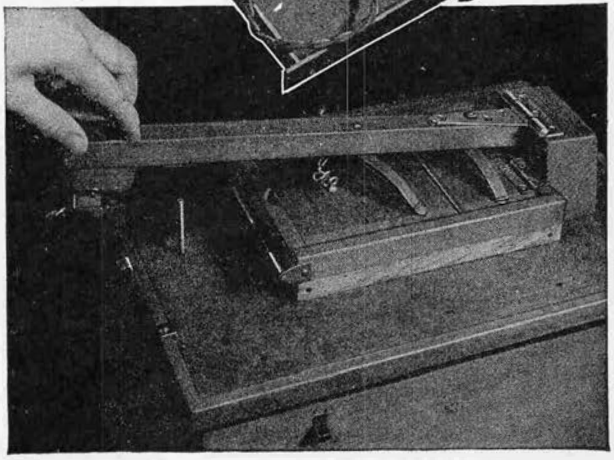


IF YOU were to figure up the time spent in fastening and unfastening the platen of your photo printing frame and moving the whole into position to make the exposure, you would find that the wasted minutes amounted to a large percentage of the time spent in the darkroom. With a printing box like the one illustrated, you could have the print in the developer by the time you are ready to make the exposure with an ordinary printing frame.

This printer has been tested with a high-grade electric exposure meter and found to give even illumination over the entire surface of the printing frame. It is very fast, the exposures ranging from two to ten seconds.



How the switches, lamps, and reflector are arranged. There should be a separation of ½ in. between the red and white lights



When the lever is pressed down, it closes the frame and turns on the white lamps, making the exposure

The necessary parts are few. Some of them you may have on hand; the remainder can be bought from regular dealers without difficulty. The box shown cost less than three dollars for materials, yet it contains all the refinements of the average factory-built amateur printer.

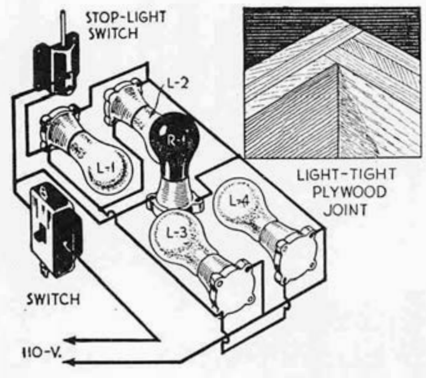
The box itself may be constructed of ¼-in. three-ply wood, or a wooden box from your grocery store may be used. The over-all dimensions are roughly 10½ by 14½ by 11 in. high. An additional feature is a drawer for the safe storing of exposed or unexposed printing paper. The drawer is approximately 10¼ by 12½ by 1 in. All dimensions, of course, may be altered to suit your needs.

A regular printing frame or an automasking frame may be used, but the time saved by the automasking type makes it worth the additional expense. In this case, a 5 by 7-in. frame was used. Make another plain frame of ½-in. strips and glue or nail it to the underside of the printing frame so as to block the latter up high enough to enable the masking arms to be adjusted easily.

Remove the two springs from the platen (pressure board) by drilling with a ⅛-in. drill, and hinge the platen to the frame as shown. Then cut a hole in the center of the box (in this case, 5 by 7 in.), and glue or nail the altered frame in place.

Cut a block of wood from a 2-in. thick stock, making it 3 in. wide at the top, 4 in. at the base, and 2 in. high. If plywood is used for the top of the box, it should be reenforced underneath with 1-in. stock, because a great deal of strain comes at this point. Fasten the block where indicated in the upper photo with three or four long wood screws driven up from below.

Next hinge the lever arm, which is cut from 1-in. stock 15 in long, to the block, and fasten the springs with ⅛-in. stove bolts to the arm opposite to their former positions on the platen. Hold the lever arm in a horizontal position to determine the proper place for setting an elbow catch and hook.



Methods of making light-tight joints with plywood, and wiring diagram for the printer. *R-1* is a 25-watt photo-red lamp; *L-1, L-2, L-3,* and *L-4* are ordinary 40-watt inside frosted lamps

The momentary contact switch used to turn on the lights for the exposure is merely an automobile stop-light switch, which may be purchased from a dealer in auto supplies. The arm of this switch is extended with a 3/16-in. brass rod. Drill a ⅛-in. hole in the end of the brass rod; then machine or file the arm of the switch down to ⅛ in. and solder or "sweat" it in place. Drill a hole in the top of the printing box where the extension rod strikes, and adjust the height of the switch so that it closes contact when the lever arm is pushed down and the parts of the elbow catch snap together. Screw the switch in this position.

An alternative method of extending the arm of the switch would be to use ⅜-in. wooden dowel stock.

The chain is fastened with small screw eyes, the length being adjusted to raise the platen and allow the lever to be raised in a vertical position.

The wiring and arrangement of lights is shown in the diagram. One 25-watt photo-red lamp and four 40-watt lamps are used. The white cardboard reflector improves the illumination. Some builders of printing boxes, especially if only one or two lamps are used, insert a piece of flashed opal glass to diffuse the light more completely, although you may not find it necessary to do this.

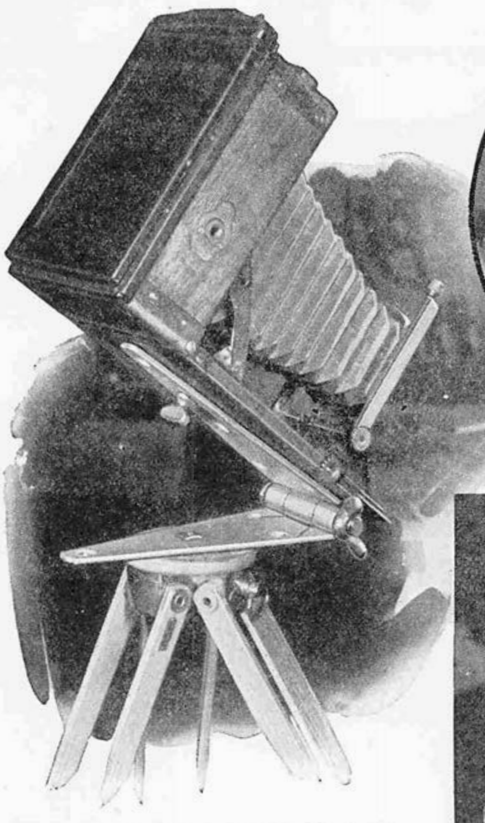
The top is held in place with neat turn buttons—½-in. pieces of 1/16-in. brass cut from an old hinge, the holes being off center. Hinges could be used at the back, if preferred.

Give the inside a coat of flat white paint and finish the outside with varnish or shellac.

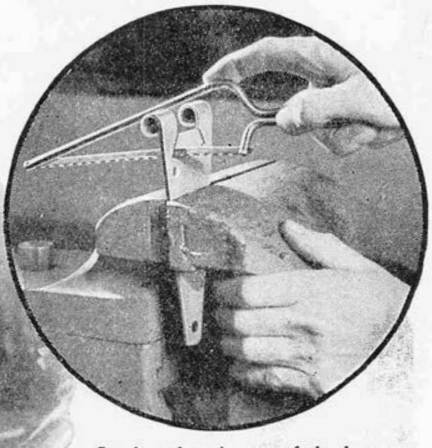
PHOTOS TAKEN WITH AID OF PRINTING FRAME

Photographs, letters, charts, pieces of lace, or anything thin and flat of which a photograph is desired may be held in a photographic contact printing frame. This keeps the article flat without using pins, thumb tacks, or glue and there is no possibility of curling due to the heat of any lamps that are used close to the work.

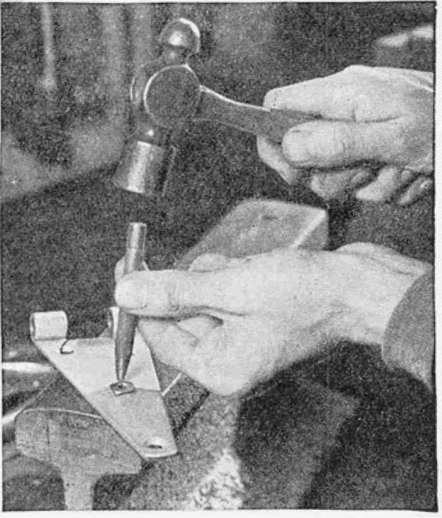
Tripod *Tilt*-*Top* MADE FROM STRAP HINGE



Although made from a ten-cent hinge, this tilt-top is rigid enough for most cameras



Sawing slots in one of the leaves so the hinge joint can be locked

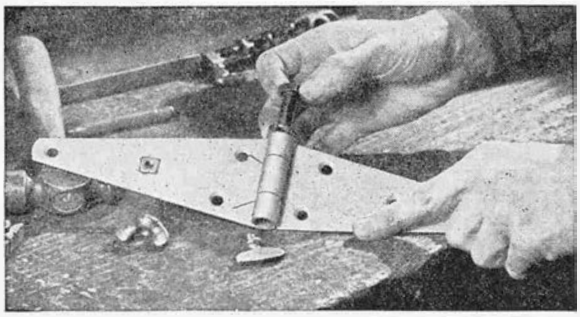


A nut is inserted into a square hole in the hinge and held by punching down the metal

A SERVICEABLE tilting top for camera tripods can be made at a cost of a few cents from a large strap hinge such as those sold for use on barn doors. When the device is used between camera and tripod, the camera can be tilted at any angle for photographing objects on a table top, copying pictures, photographing insects, and the like. By reversing the camera so that the lens points in the direction of the open part of the hinge, pictures can be taken of tall buildings, clouds, and other objects in high positions.

Remove the pin from the hinge by filing or grinding one end until it can be driven out with a punch. Place in a vise the half of the hinge that has two turned-over projections, and make hack-saw cuts as shown in the photographs. This is to make it possible to force the two projecting parts slightly toward each other. Reassemble the hinge, using a machine bolt the same size as the pin that was removed, and a wing nut that can be turned easily with the fingers. Place a lock washer under the bolt head to prevent it from turning. By tightening the wing nut, you can lock the hinge joint.

Most cameras have tripod sockets that take a ¼-in. bolt having 20 threads per inch, and therefore standard tripods are fitted with a screw of that size. For attaching the hinge to the top of the tripod, fasten a ¼/20 nut over a hole in the center of one of the leaves. You can solder this nut directly over a drilled hole; or make a square opening with file and chisel, insert the nut, and fasten it securely by using a punch to spread the metal near the junction lines.



The two members of the hinge are fastened against slipping by means of a bolt, wing nut, and lock washer

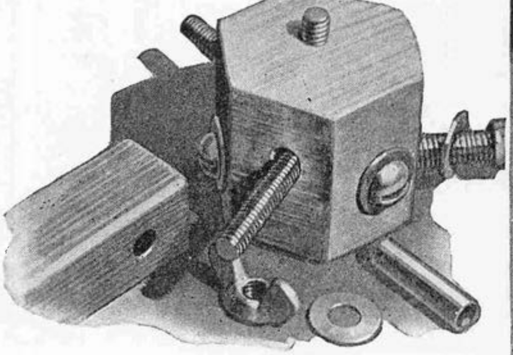
In the other leaf of the hinge, drill a hole at a point where it will engage the camera tripod socket when the camera is held so that its bed does not interfere with the operation of the wing nut. A short ¼/20 bolt with a knurled or winged head passes through this hole into the camera socket.

If desired, the projecting ends of the leaves can be cut off to shorten the device.

HERE'S A HOMEMADE

Camera Tripod

that never slips, sways, or skids



So rigid is the tripod that it can be lifted by one leg and carried from place to place without disturbing its adjustment. The head is shown above

ONE of the old comedy stand-bys is the photographer whose tripod collapses just as he is taking a picture. It is funny to the audience, but no laughing matter to the serious picture taker. Any one who has attempted to set up a tripod on a tin roof or a polished ballroom floor knows just how exasperating a task it is.

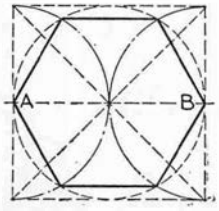
There are, of course, various devices on the market for steadying tripods, but the homemade tripod illustrated is designed so that the bracing is an integral part of the tripod itself. It requires less material than a standard wooden one of identical size, contains fewer parts, weighs considerably less, and still sacrifices nothing in strength or rigidity. On the contrary, it is more adaptable to the "grab and run" tactics needed at ball games, athletic contests, and in crowded places. The entire tripod, camera and all, may be held over the head with one hand, while the photographer mills through the crowd, carrying his flash gun and kit in the other hand.

The design goes back to fundamental principles. First, the axis of the legs was changed from radial to tangential so that any tendency to slip must be transferred through an angle of ninety degrees to become effective. Second, clutch plates were incorporated in the hip joints of the legs. When tightened, they grip like a bulldog.

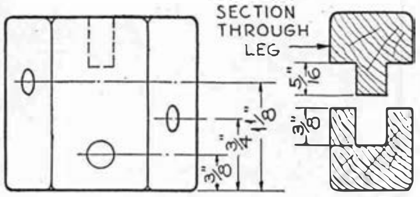
Third, the legs telescope on tongue-and-groove ways. No matter how far or how little they are extended, there is no side sway or tendency to be weak in the knees.

The tripod is ideal for home movie work, because waxed floors, gable roofs, and heaving decks are all one to it. When once set up, it stays put, and the photographer can concentrate on his picture.

Accurate construction is essential if the tripod is to be a success. A circular saw will save much work, and a drill press also comes in handy. However, a fine tripod may be turned out with only hand tools, if proper pains and plenty of patience are employed.



The tripod head is a block of hard maple 1¾ by 2 by 2 in., cut to a hexagonal shape. The legs are made of 1-in. square mahogany and are tongued and grooved at the joints



One of the assembled leg joints is shown in the photo at the right

The maple block (see the list of materials near the end of this article) must be cut into a hexagon. There are various ways to lay out a hexagon within a square—in this case, a 2-in. square. One of the simplest is as shown in the diagram. Find the center by drawing diagonals, and draw line *A-B,* dividing the square in half. Then inscribe a 2-in. circle and, using the same radius, draw arcs with points *A* and *B* as centers. Where these arcs intersect the circle are the other points of the hexagon.

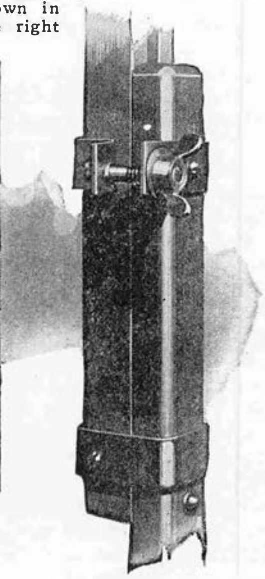
One of the four 1¼-in. long machine screws is to be used to hold the camera to the tripod head. The standard American thread is U.S.S. 20. If your camera is European, it may have the Continental thread, which requires a special screw. This can be obtained from the dealer who handles your make of camera.

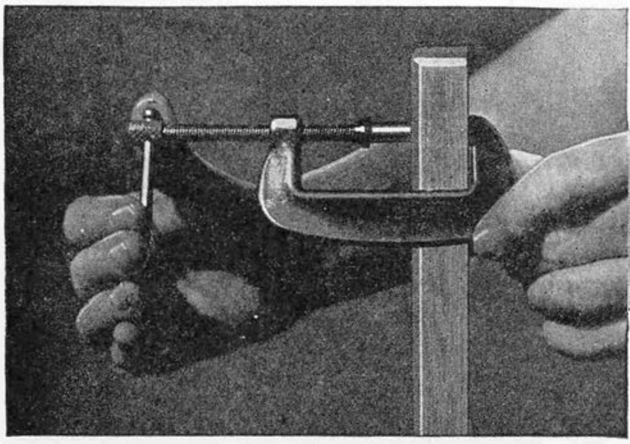
If a tap is available, the wood can be threaded to receive the screw. To align the head, center it in the drill press and bore a 3/16-in. hole ½ in. deep. Then place the tap in the chuck and feed by hand very slowly, using considerable pressure on the press.

An alternative method is to bore a ¼-in. hole, smear the threads of the screw with a wood plastic compound, and drive it in place. The composition will harden overnight and be almost as solid as if the wood itself were threaded. If the screw protrudes too far, file off the end.

Bore ¼-in. holes in each face as indicated on the diagram, staggering them sufficiently so that they do not meet internally. This is the most exacting part of the entire construction. If the holes are not exactly perpendicular, the clutch plates will not bear evenly.

The longer pieces of mahogany are the upper sections of the legs. Round the corners of the upper face, and plow a groove in the lower face to receive the tongue, which is to be cut on the lower section. A dado saw will dig out this groove in a minute, and a single blade will make it in two or three cuts. If the





The holes at the top of the legs through which the clamping screws pass are bushed with brass tubing, ¾ in. long. To avoid damaging the wood, the bushings are pressed gently into place with a C-clamp work is done by hand, a plow plane such as is used for grooving window screens is the best tool. A marking gauge and wood chisel, in the hands of a skillful craftsman, also will turn out a creditable job.

The upper section of the leg is just right for waist-high picture taking. Unless eye-level shots are desired, there will be no need of adding the second section. A sleeve bearing is inserted in the hip joint of each leg. Bore a 9/16-in. hole and insert a section of telescopic tubing. This is so called because one size makes a sliding fit over the next smaller size. The 9/16-in. tubing makes a perfect bearing surface for the ¼-in. threaded rods. Start it in by lightly tapping with a wooden mallet, then adjust a C-clamp and squeeze it into place. Start from the upper face. The sleeve should not go all the way through, or it will interfere with the clutch surfaces.

Now cut the tongues on the lower leg members to give a sliding fit, not too loose. The members should make contact on the lips of the groove, not the bottom of the tongue.

Bend the metal strapping as shown, fitting each piece to the leg individually. A small vise and wooden mallet are the only tools required. Drill the required holes and fasten the strapping.

The friction catches give an audible indication when the legs are extended to maximum, and also automatically equalize the length of the legs.

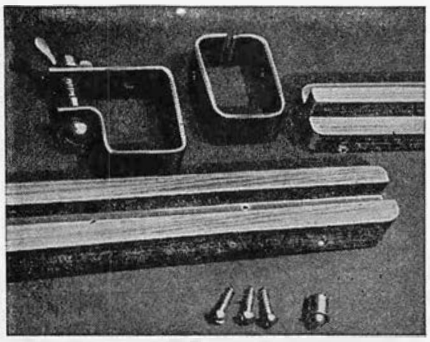
The tripod may be stained if desired, but do not paint or varnish it. Apply a coat of hot beeswax, rubbing it well into the wood. This acts as a lubricant for the channels, does not scuff or scar, and presents a professional appearance. Rubber-headed tacks make good feet.

Professional photographers agree that good pictures may be obtained consistently only with the aid of a tripod. When the petty annoyance of a temperamental tripod is eliminated, the photographer is enabled to select better action and composition.

A ball-and-socket joint between tripod and camera increases the flexibility.

List of Materials

- 1 pc. hard maple 1¾ by 2 by 2 in. for tripod head.
- 3 pc. mahogany 1 by 1 by 43 in., and 3 pc. 1 by 1 by 26 in. for legs.
- 3 U.S.S. 20 brass machine screws, ¼ by 3 in.
- 4 U.S.S. 20 brass machine screws, ¼ by 1¼ in.
- 6 wing nuts and 9 washers for the screws.
- 6 pc. brass strapping, 1/16 by 1 by 5 in.
- 3 ball-type friction catches, ¼ in.
- 9 roundhead brass wood screws, ½ in.
- 3 pieces of telescopic tubing, 9/16 in. in diameter and ¾ in. long.

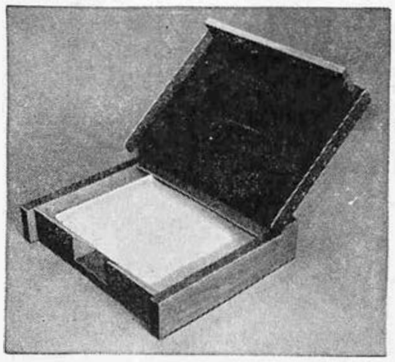


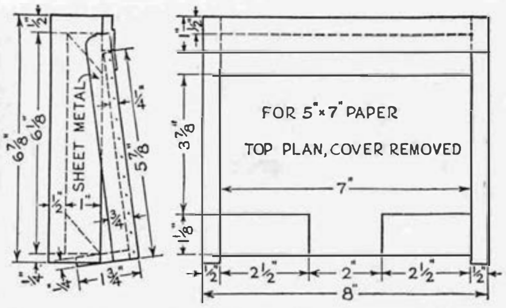
The hardware and fittings for each leg joint

BOX KEEPS ENLARGING PAPER HANDY

When a number of photographic enlargements are to be made, all of the same size, a box of the type illustrated below will be found a great timesaver. The effort required to make a few of these boxes to fit the most used sizes of bromide paper will well repay. The sloping sides make the pack of paper splay out sufficiently to enable the top sheet to be quickly grasped. The hinge is a continuous strip of leather.

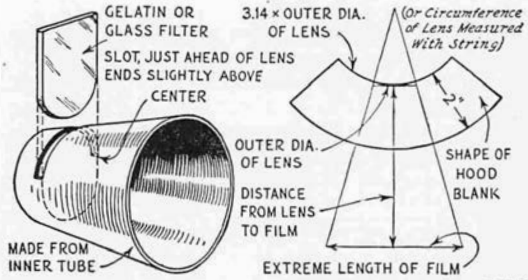
When painted a flat black, inside and out, the box will be found adequately tight, even in full daylight, for a reasonable length of time.



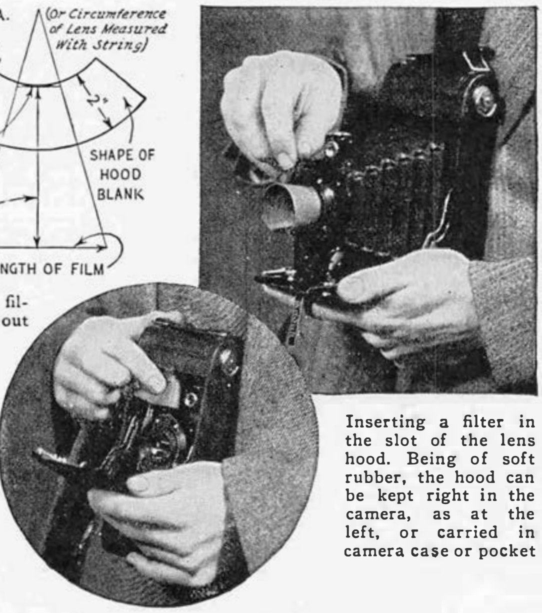


The box has sloping sides so that the top sheet of paper can always be quickly grasped. The lid, which has a long leather hinge, is reasonably light-tight

LENS HOOD MADE FROM OLD INNER TUBE


GELATIN OR GLASS FILTER
SLOT, JUST AHEAD OF LENS ENDS SLIGHTLY ABOVE CENTER
MADE FROM INNER TUBE
3.14 × OUTER DIA. OF LENS
(Or Circumference of Lens Measured With String)
2"
OUTER DIA. OF LENS
SHAPE OF HOOD BLANK
DISTANCE FROM LENS TO FILM
EXTREME LENGTH OF FILM

The hood with slot for holding filters, and a diagram for laying it out



Inserting a filter in the slot of the lens hood. Being of soft rubber, the hood can be kept right in the camera, as at the left, or carried in camera case or pocket

EVERY photographer, amateur or professional, knows that it is essential to keep the sun or any strong artificial light from shining directly on the lens of a camera. A flexible hood for this purpose may be made in less than five minutes from a discarded automobile inner tube. This hood will also serve as a holder for color filters and screens.

To make the hood of the correct shape to afford maximum protection without obstructing the line of sight of the lens, proceed as shown in the diagram. Make a paper pattern for cutting the rubber. Use an ordinary rubber inner-tube patch for cementing the two edges of the hood together; then paint the entire hood a dull black. The smaller end of the hood will fit snugly on the projecting shoulder of the lens and will support the hood firmly in place.

Color filters or screens may be inserted in the hood from the end, or more handily, through a slot cut just ahead of the camera lens itself. The latter method offers an additional advantage in that unmounted, and therefore less expensive, filters and screens may be used.

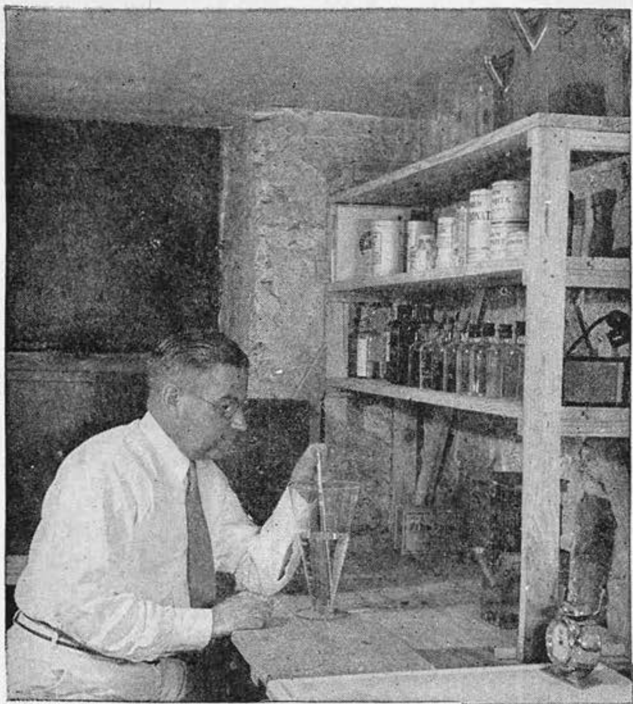
Photographing Shiny Objects

ONE difficult problem for the amateur photographer is to photograph an object with strong highlights such as cut glass or polished metal.

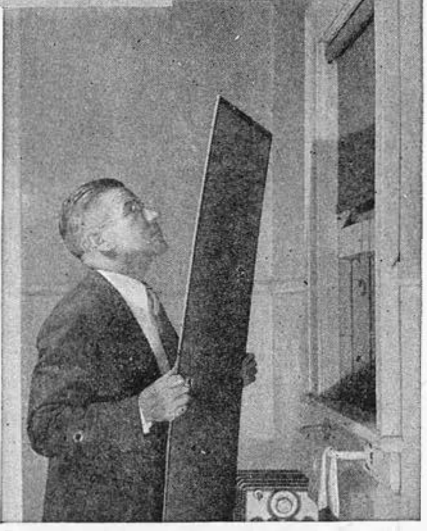
The most suitable material for taking a picture of this type is modern film of either the verichrome or supersensitive panchromatic type. Cut film is not quite so good, and glass plates are very poor.

The lighting should be as even and full as possible so as to get the high-lights well distributed and all of the surface well illuminated. Underexpose a trifle, rather than overexpose.

IT'S EASY TO FIT UP A Darkroom *in* Any Home



The cellar darkroom in which the author works. The window at the left is made lightproof by a plywood blind. The workbench and chemical storage shelves were built from the cheapest yellow pine sheathing



For any window such as in this bathroom, a blind can be made from a piece of ⅛-in. pressed-wood board edged with black velvet

ARRANGING satisfactory darkroom facilities without upsetting the rest of the family is one problem every amateur photographer has to face as soon as he gets beyond the press-the-button, let-someone-else-do-the-rest stage of the hobby.

Indeed, many amateurs of the type to whom developing, printing, and enlarging make a strong appeal are scared off by the apparent difficulties. Actually it is quite easy to fix up a good darkroom without disturbing anyone, even in a small apartment.

The first question: How dark must a darkroom be and how can it be made that way? The answer depends on what work you expect to do. If you have a roll-film camera, develop your films in a daylight-loading tank, make prints on velox or similar paper, and do not go in for bromide enlarging, any room in your home will be dark enough at night without even bothering to pull down the shades.

If, however, you develop roll films in a tray, develop film packs, cut films, or plates, or do bromide enlarging, you must have a darkroom that is absolutely free from light. A perfect darkroom, photographically speaking, is one you can sit in for fifteen minutes with all lights out and at the end of that time not be able to see a single thing—not even so much as a vague hint of light around the door or window frames.

Your first thought will be to hang blankets over the windows to cut off the light. That will do in an emergency, but is a nuisance as a regular practice. It is much better to fit light-proof blinds to the windows and fix the door so no light gets in around the edges. The details of this job depend on the windows in the room and the type of door, and they, in turn, will differ according to the room you choose or must, through force of circumstances, use for your darkroom.

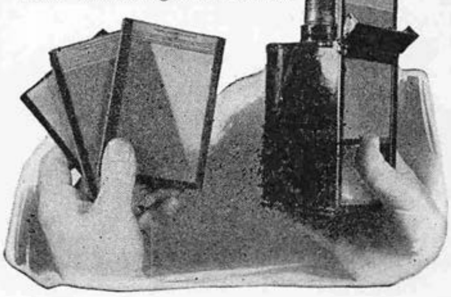
If you live in a private house, obviously the best location for the darkroom is the cellar, preferably in the laundry where there is running water. In a small apartment, the bathroom is a logical choice for the same reason. On the other hand, any arrangements you make in the bathroom of a small apartment must not interfere with its normal use or make the room unsightly, otherwise there will be strenuous objections from the other members of the family.

The kitchen also is an excellent choice, especially the modern type with its large single or double drain-board sink. A point in its favor as a darkroom is that ordinarily you can have undisturbed use of it after the supper dishes are out of the way.

Bear in mind that running water is not an absolute necessity. If you are forced to choose between any reasonably large closet that you can use exclusively as against the uncertain tenancy of a bathroom, by all means choose the closet. Carrying a few pails of water of an evening is but a small price to pay for no interruptions.

Cellar windows are usually small and easily fitted with light-tight blinds made of thin plywood or pressed-wood board. The exact method of fitting depends on the type of window. Looks will be of small importance in the cellar, so all you have to remember is that light cannot get around two right-angle corners that are painted flat black, even if the joints are quite loose.

The topmost illustration on this page shows a corner of a cellar darkroom. The window at the upper left is fitted with a plywood blind. Three dollars' worth of yellow pine sheathing—about the cheapest lumber you can buy—supplied the wood needed to build the workbench and chemical storage shelves, which are placed next to the enameled iron tub tops. This a convenient arrangement, gives you lots of room to work, and does not interfere with the normal use of the laundry tubs on wash day.



An inexpensive darkroom light with interchangeable screens

If you will examine most bathroom or kitchen windows, you will find there is a flat surface on the frame all around the casement that is broken only by the projecting sill at the bottom. The second photograph above shows a blind being applied to such a window. It is made of ⅛-in. pressed-wood board with a strip of black velvet ribbon glued close to the inner edge and around the bottom edge where it rests on the sill. When held in place with a few thumb tacks or tiny swinging wooden cleats, it is absolutely light-tight.

When not in use, the blind can be left standing behind the radiator where it will not be in the way and will hardly be noticed if the inside surface is painted to match the walls.

But little light gets through most reasonably well-fitted doors except under the bottom. There sometimes is as much as a ¼-in. space between the door and the sill or floor. Glue the edge of a thin velvet ribbon close to the bottom edge of the door to curtain off this unwanted light. With poorly fitted doors, such as a cellar door, or one that has warped badly, it may be necessary to glue a strip of ribbon all around the edge to stop light coming around the jamb. If the door is of any dark color, the ribbon can be of a matching color to make it inconspicuous.

Once you have the darkroom really dark, the next job is to install a safe darkroom light. The third illustration on page 68 shows the cheapest form of safe darkroom light. Colored glass screens of different kinds, ranging from the exceedingly dim green that is safe with panchromatic film, if used with discretion, to a bright yellow that gives lots of absolutely safe light for velox or similar papers. are obtainable for this light and are easily slipped into place as indicated. You can buy these safelight screens separately in this smallest size or in larger sizes, if you prefer to make your own light-tight box for them.

REMEMBER that only the makers of the films, plates, or paper you use really know just what kind of light and how much of it their products will stand without fogging. If you try to fix up a darkroom light with untested material such as red, green, or orange electric light bulbs, you will either have too much of the wrong kind of light and fog your films or have a much dimmer light than would be permissible if of exactly the right color for the work you are doing.

The next problem is where to put the trays. This is simple in the cellar darkroom illustrated because there is plenty of working space. In a kitchen darkroom, the drain board of the sink does for the developer, short-stop, and fixing trays, and the sink itself serves for a wash box if you knock the bottom out of a small tomato can and place it over the drain so that the water has to rise to the top of the can before flowing out.

The modern bathroom washbasin rarely offers a safe support for one tray, let alone three. One solution, if the arrangement of the room makes it convenient, is to cut a wide board long enough so that it can be supported lengthwise or crosswise on the tub. The latter, when filled with water, makes an acceptable wash tank.

If the room is planned so that it is convenient, it may be possible to make a detachable shelf that will fit on top of the toilet flush box after the porcelain cover has been lifted off. This works well if the flush box is beside the washbasin and at the right height.

IN the closet type dark room where there is no running water, the most difficult problem is to get your hands clear of hypo before you put them back in the developer. The answer is to carry in two pails nearly full of water. Always rinse your hands first in one and then in the other in the same order, then dry on a towel. This double rinsing will remove so much of the hypo that what's left on your fingers won't do any damage.

The final washing, too, can be conveniently done in a darkroom without running water. Adequately complete washing of any photographic film, plate, or paper is obtained if the water in the tray is changed at least six times at five-minute intervals. One empty pail into which to pour the discarded water and one full one from which to obtain the fresh fillings of the tray will therefore do the trick. This method of washing saves quite a lot of water, which is a matter of importance if the water rate is high in your locality.

The last and perhaps the most important of all darkroom problems is the matter of cleanliness. Photographic developing and printing are delicate chemical processes. Uniform and satisfactory results cannot be obtained with dirty trays and careless handling that allows any chemical to get where it does not belong. Do not fail to wash out each tray after using it.

WRITING HOME MOVIE TITLES ON FILM STORAGE CANS

IT IS difficult to write film titles on the humidor cans in which amateur motion picture film is kept. This problem may be overcome, however, if the space in which the title is to be written is thinly coated with film cement. Then, after writing the title in ink, another coat of film cement is applied so the letters will not rub off.

LIGHTPROOF BOX SERVES AS

Portable Darkroom

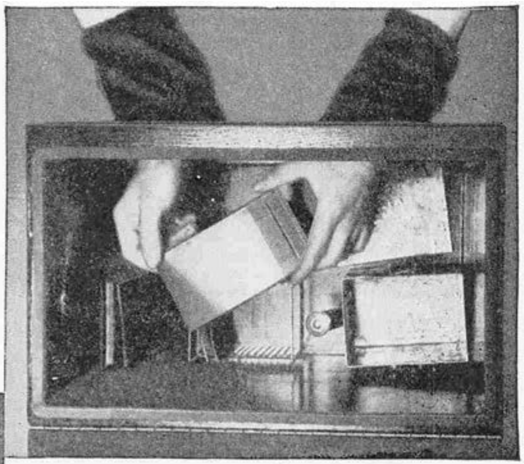
ON CAMPING TRIPS

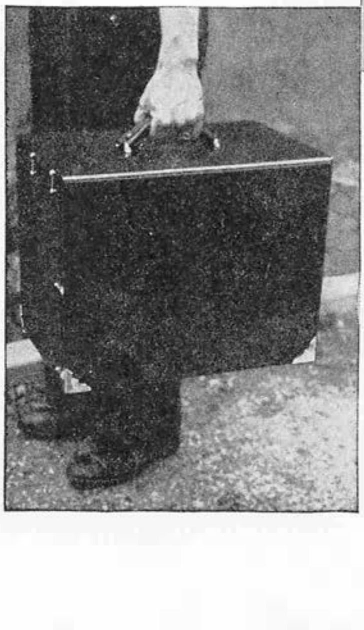
MANY amateur and not a few professional photographers take their equipment on boating, fishing, or camping trips and often desire to develop the negatives before returning. This need led to the construction of the developing box illustrated. It is used for loading cut-film holders and for transferring exposed films to a daylight developing tank. In addition, it provides a safe place to keep or carry films, negatives, and cameras. For those who use roll-film cameras and daylight developing tanks, a similarly constructed box will solve the problem of loading the tank.

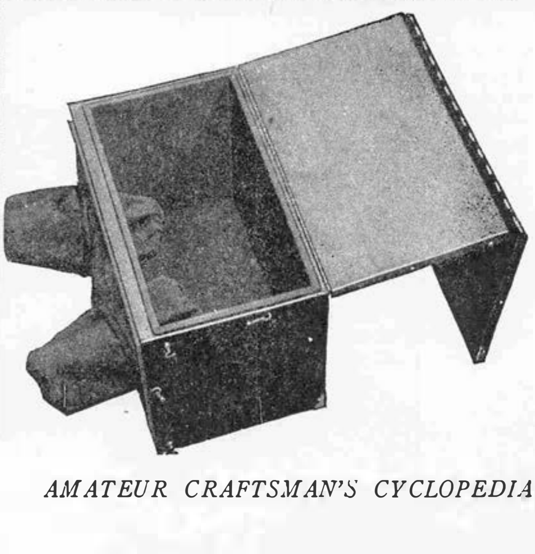
Spruce ⅝ in. thick (any light, soft wood is suitable) was fastened with screws and waterproof glue to form the box, which is 12 in. high, 10 in. deep, and 16 in. long, inside dimensions. This gave the right amount of space for a 9 by 12-centimeter outfit. A roll-film outfit would not require so large a box.

The crosspiece above the apron was made of 1¼-in. square oak. The two long cover hinges were taken from old battery radio sets. The rubber apron was made by cementing black sateen cloth to one side of brown rubberized cloth with rubber cement. The double sleeves were made up separately with elastic at one end of each, then sewed and cemented in the apron front, which is the same material. The rubber surface should be on the inside of the box to facilitate wiping out the dust.

To make the box water-tight, dustproof, and light-tight, a strip of sponge rubber (such as used around car doors) was cemented in a shallow rabbet around the top and front of the box so that about three fourths of its thickness projected above the wood when the covers were open. When closed, the rubber is compressed, forming a seal.



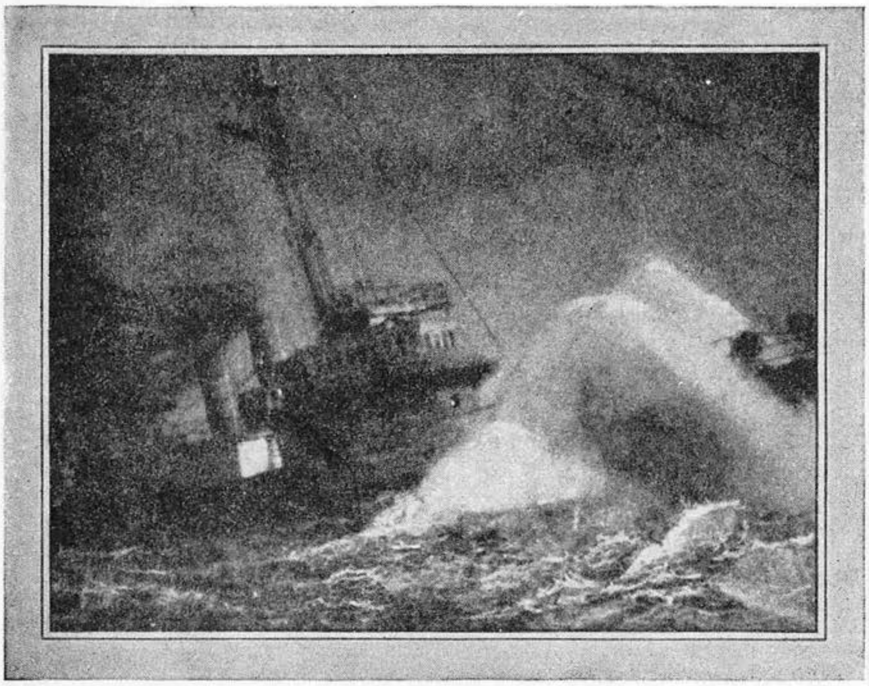




The box is shown at the right with the cover open to illustrate the method of manipulating films. The other photos show its general construction and how it looks when closed

INGENIOUS TRICKS IN
Table-Top Photography

How to take pictures as real as life by using miniature models . . . The final prints are made from paper negatives



United States destroyer in a heavy storm. This is really a picture of a model made from blueprints and set in a sea of crinkled red wax paper. The spray is fluffy cotton; the sky, a piece of composition board

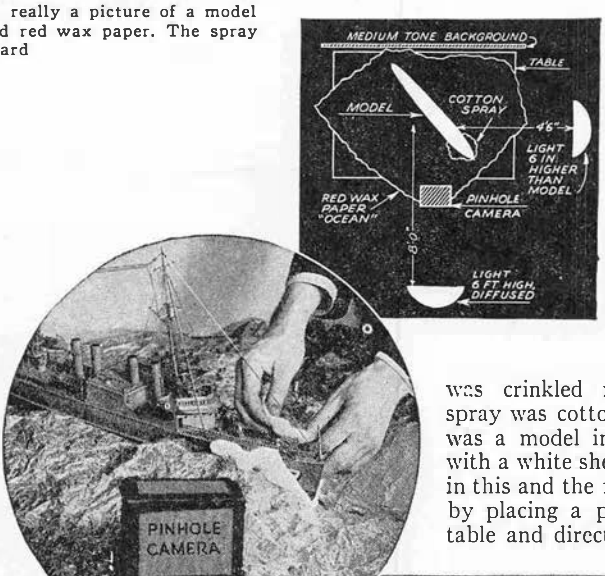
TABLE-TOP photography is the art of taking pictures of models or other miniature subjects that have been so arranged as to give a result suggestive of real life. Such photos may be divided in two classes. In one, the subject is represented as exactly what it is, but is so arranged as to suggest reality. It is the type most often seen in advertisements. In the other class, to which this article relates, the means and methods are concealed in an effort to approach actual realism, as in the example illustrated above. This is a fascinating field for amateur photographers and model makers.

Elaborate models and expensive photographic equipment are not essential. The factory scene, for example, is nothing but a sheet of tinfoil for the foreground, a piece of black cardboard for the buildings, two black paper tubes, a white sheet for the sky, and clouds of cotton hanging from a string. As for the cameras, the old-time ship was made with a small hand camera of the bellows type on a film about 4 by 5 in. The factory was taken with a 12-in. lens on a 5 by 7 in. film, and the destroyer picture on this page was made on one quarter of a 5 by 7 in. film with a homemade pinhole camera that cost ten cents. A pinhole camera is nothing but a light-tight box provided with means for holding the film inside at one end and, at the other end, with a lens made by piercing a piece of shim brass with a needle point.

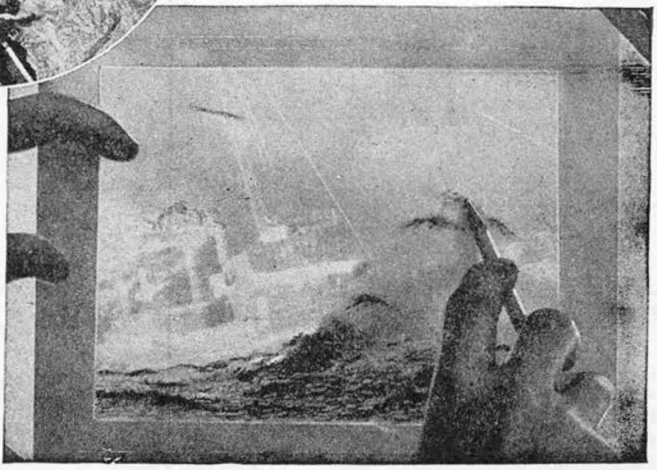
For the proper effect of perspective, the shorter the focal length the better. To have used a 12-in. lens for the factory picture seems at variance with this, but you will notice that the effect of linear perspective is not a part of this photograph. The same picture could have been made with the ten-cent pinhole camera, the only difference being that three seconds was sufficient exposure with the lens, whereas the pinhole would have required thirty or more minutes.

In order to direct and control the light and study your effects, it is best to use electric lamps for lighting the model. If you wish to do all the work personally, you will need materials and equipment for developing the negative and making a print. An enlarging camera can be used to advantage.

Now let's get to work. First, determine what your subject will be and get a clear mental picture of it. Making a rough sketch will help. The makeup of one of the models has been described. In the picture of the destroyer, the sky was builder's composition board, the sea was crinkled red wax paper, and the spray was cotton. The other ship picture was a model in a sea of red wax paper with a white sheet for the sky. The sunset in this and the factory view were obtained by placing a photo-flood bulb under the table and directing its light on the white



Arranging the set-up for the storm picture. The diagram shows positions of the model, background, camera, and lamps. A pinhole camera was used in this instance, but any small camera will do



Paper negative from which the final print was made. The highlights on the spray and the white caps were brought out by using a black pencil on back of negative

Galleon at sunset—a photograph taken with a small hand camera as shown at the right

sheet background. A second light, diffused and of much less brilliance, was directed on the camera side of the setup in order to record a slight suggestion of detail.

A minutely detailed model can stand a disclosing light from the front, but a less careful arrangement can be made astoundingly realistic by placing the main light source at one side or in back and photographing shadow or silhouette effects.

After the model is completed, the next step is to make the negative. Choose your camera position carefully. As a rule, it pays to work close to the subject and, unless you want a bird's-eye view, keep the camera low. Working close with a lens will require that it be stopped all the way down to the smallest opening.

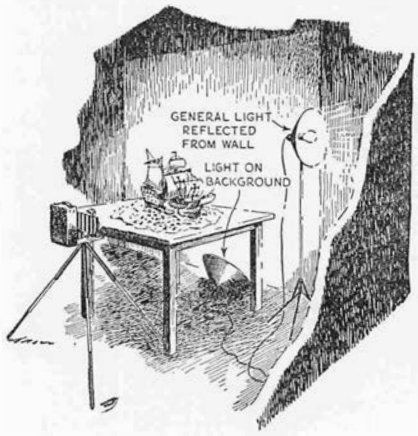
A few trials should give you a good negative. From this a contact print or an enlargement is made on single-weight, white stock paper. The enlargement is preferable for a number of reasons, one of which is that it permits extensive trimming of the negative without sacrificing size in the finished print. Strive for an arrangement that will be pleasing to the eye. The print for our purpose must be heavier and darker than a normal one. Positive detail in the highlights is, in most cases, necessary.

Examine the finished print. Do you want to darken any tones or add any dark details? If so, place the face of the print against a window or on a piece of glass with a light underneath and make additions on the back with a pencil. The pointed crest of waves and the smoke from the destroyer's funnels were made in this way. So were the power lines in the factory scene.

From this "retouched" print, a paper negative is made by placing the print in contact (emulsion to emulsion) with an unexposed sheet of single-weight white photographic paper. This may be done in a photo printer or a printing frame. Light passes through your print to the unexposed sheet and, when this is developed, the result is a paper negative. Time will probably be saved if you make several paper negatives, varying the exposure and using papers of different contrast.

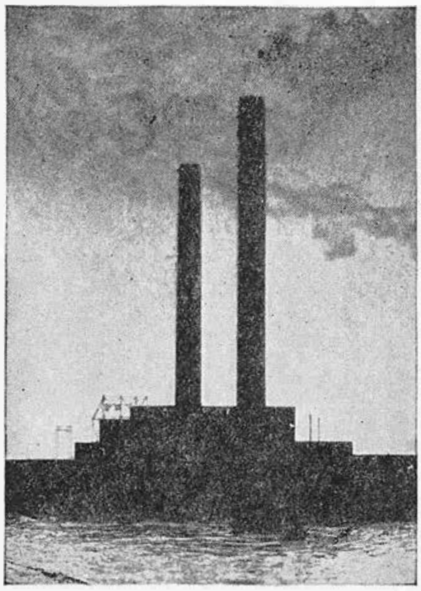
The back of the negative is worked up the same as the positive print, but this time, although we are adding black, these areas will be lighter or white on the finished print, depending on the strength of the pencil work. The highlights on the spray and the white caps in the destroyer picture and also the light in the stern lantern of the old-time ship were added in this way.

The paper negatives are used the same as glass or film for making the finished contact print. Use glossy single-weight paper for the preliminary steps but for the final print a choice should be made of the most appropriate of the many attractive tints and surfaces obtainable.



This is how the galleon picture was taken. Note arrangement of lights for sunset effect

A further advantage is the fact that no expensive equipment is required. The pinhole camera, except in its lack of speed, is better for most of this work than the most costly camera you could buy. If you do not have an enlarger, a photo finisher will make an 8 by 10 in. enlargement from a small negative for a dollar or less.



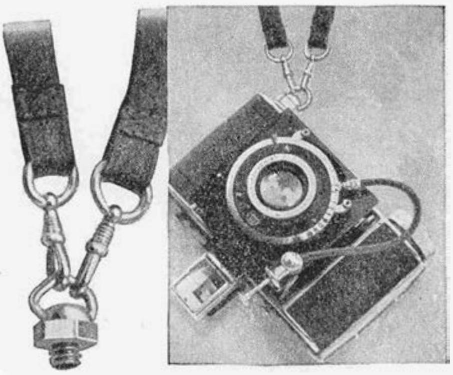
The factory is cardboard; the water, a sheet of tinfoil. The clouds are wads of cotton

EXPERIMENTAL PHOTO FILTERS

SMALL circles of colored transparent wrapping material of the cellulose type can be used as experimental color filters on your camera. Yellow, orange, red, and green are the most useful colors. For temporary use, coat the lens flange with rubber cement and immediately stretch the thin cellulose material over it without wrinkles.

NECK-STRAP ATTACHMENT FOR SMALL CAMERA

WHEN using a miniature camera for so-called "candid" photography, it must often be ready for split-second shots and instant concealment when the work is done. Getting even the most compact midget camera from a pocket quickly is difficult, and a fumble can cost dearly in repairs. If, however, it is slung from a strap around the neck, the small camera is easily concealed beneath the coat and readily brought into play; also, the hands are left free between exposures.



Most of the less expensive miniature cameras have no built-in features to which a neck strap can be hooked, and the camera body is usually of such thin metal that it is inadvisable to attach a pair of rings. Instead, the tripod socket, usually fitted with what is known as "American thread," can be utilized to hold a single ring for attaching a neck strap.

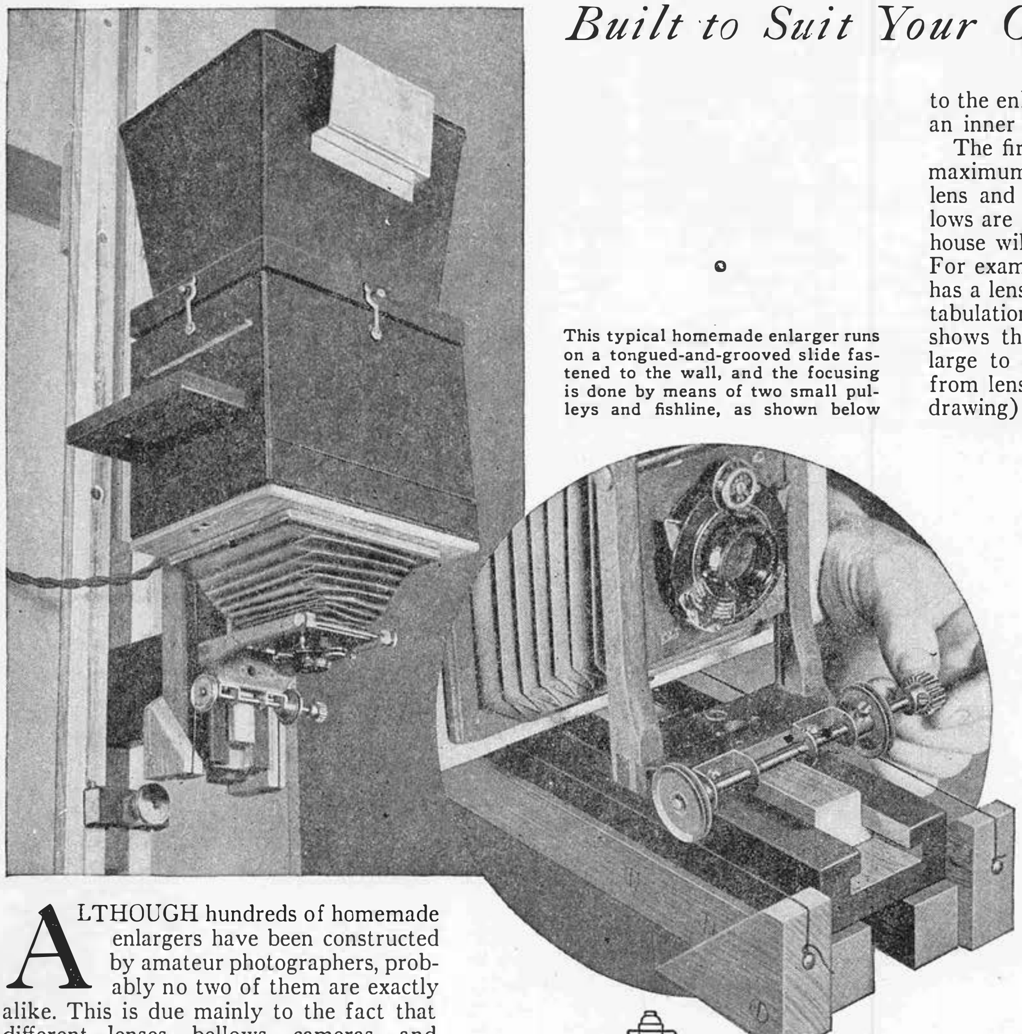
Cut the end from a common stove bolt with a ¼-20 thread to leave about ¼ in. projecting after this threaded end is screwed into the tripod cavity. A 1/16-in. lateral hole then can be drilled to insert a ring. A neater job results, however, if the free end is capped with a nickeled hexagonal nut secured with a drop of solder and the ring hole drilled through this. The threaded end cut from the stove bolt should be long enough to go fully into the tripod socket and yet be short enough to allow the hexagonal nut to fit tightly against the edge of the socket to keep the device from working loose.

A good neck strap can be cut from a woman's discarded belt. A strip of narrow leather belting or a dog leash from the "five-and-ten" does almost as well. Three screw eyes, their points cut off with a hack saw, will serve as the rings if no others are available. Two are sewed to the ends of the neck strap with beeswax thread. Hooks to connect them with the main ring can be salvaged from cheap or discarded jewelry.

Sometimes both the finger and cable shutter releases are in unhandy places on cameras of this type. A more convenient release can be made by tapping holes both in the front plate of the camera and any small nickeled knob (the one pictured held the bell on an old-fashioned alarm clock), and attaching the knob with a beheaded machine screw. A lateral hole is drilled in the knob and enlarged with a rat-tail file to accommodate the tapered shank of a short cable release. The shutter can then be operated by easy downward pressure of the forefinger without any fumbling.

LOW-COST Enlarging Camera

Built to Suit Your Own Needs



This typical homemade enlarger runs on a tongued-and-grooved slide fastened to the wall, and the focusing is done by means of two small pulleys and fishline, as shown below

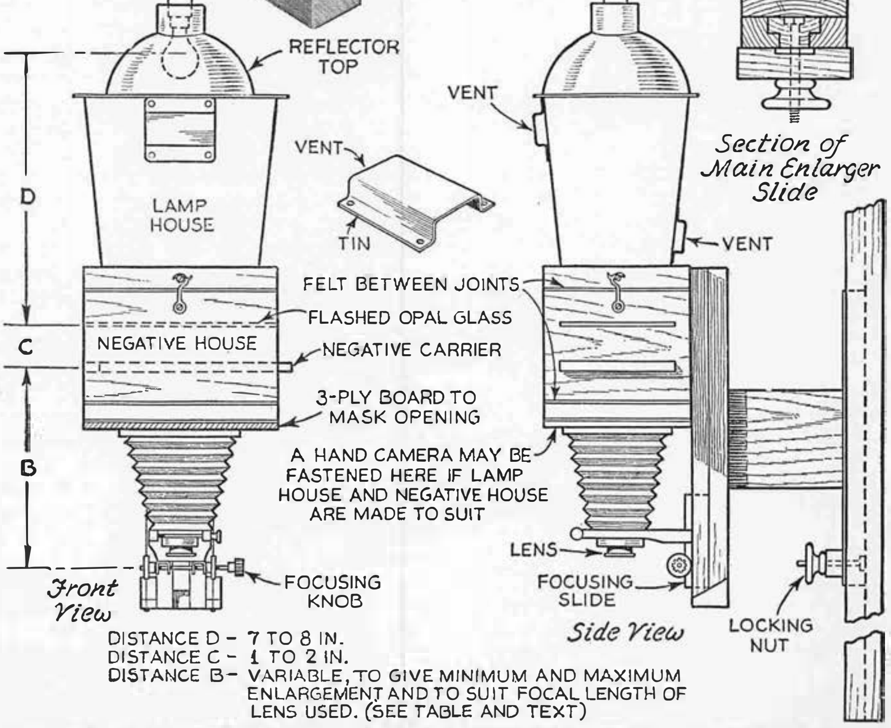
ALTHOUGH hundreds of homemade enlargers have been constructed by amateur photographers, probably no two of them are exactly alike. This is due mainly to the fact that different lenses, bellows, cameras, and other materials are on hand in every case. Instructions for making one particular enlarger having a certain specified lens equipment would not, therefore, be of much help to any but a few readers of this book. Accordingly, it has been decided to give a set of general instructions which can be adapted to meet each reader's own requirements. So much added enjoyment is obtained when one can view enlargements from his own negatives that the labor involved is well repaid.

The efficiency of a homemade enlarger depends upon the care given its construction and upon the quality of the lens used. Prints from the one illustrated have been hung in several photographic salons, and there is no reason why you should not build one every bit as good as a factory-made model of corresponding type.

Providing the camera bellows are adjustable, your regular camera may be used as part of the enlarger. While this will reduce the cost considerably, it is not an unmixed blessing. When you want the camera for one purpose, it is tied up on another job, so that if you can obtain a second-hand camera with a fair lens, by all means do so. Should you decide to use your regular camera, some means will have to be devised for clamping it temporarily to the enlarger. Strong rubber bands from an inner tube will serve.

The first thing to be determined is the maximum and minimum distances between lens and negative. If the camera or bellows are of limited extension, the negative house will have to compensate this fault. For example, suppose the camera available has a lens with a focal length of 4 in. The tabulation near the end of this article shows that when focused sharply to enlarge to double dimensions, the distance from lens to negative (distance *B*, in the drawing) will be 6 in. At the position for a seven-times enlargement, distance *B* will be 4 4/7 in. Now a camera with this lens equipment usually has a bellows permitting an extension of only about 4½ or 5 in. at the most, so the negative carrier must be moved up in the negative house the difference between the extension of the bellows and the extension necessary for the two-times enlargement (i.e., 1½ or 1 in. farther from the camera back).

Assuming that you have the lens bellows or camera to be used, it would be well at this stage to make a rough sketch and mark down all measurements as they are determined. This will give you something definite to work from.

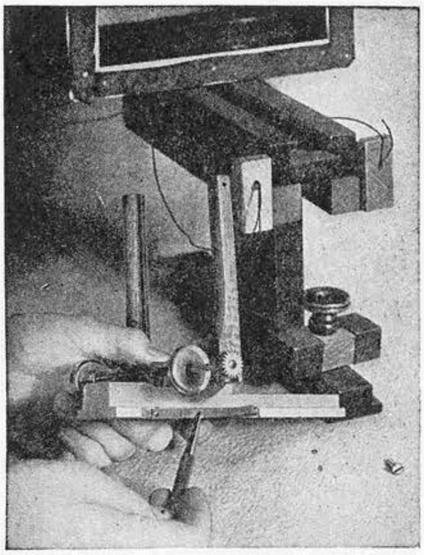

REFLECTOR TOP
D
LAMP HOUSE
C
NEGATIVE HOUSE
B
Front View
VENT
TIN
FELT BETWEEN JOINTS
FLASHED OPAL GLASS
NEGATIVE CARRIER
3-PLY BOARD TO MASK OPENING
A HAND CAMERA MAY BE FASTENED HERE IF LAMP HOUSE AND NEGATIVE HOUSE ARE MADE TO SUIT
FOCUSING KNOB
VENT
VENT
LENS
FOCUSING SLIDE
Side View
Section of Main Enlarger Slide
LOCKING NUT
DISTANCE D - 7 TO 8 IN.
DISTANCE C - 1 TO 2 IN.
DISTANCE B - VARIABLE, TO GIVE MINIMUM AND MAXIMUM ENLARGEMENT AND TO SUIT FOCAL LENGTH OF LENS USED. (SEE TABLE AND TEXT)

The details of construction may be varied to suit the available materials and type of reflector used. Groove walls of the negative house for the negative carrier and opal glass before assembly

BASIC DIMENSIONS FOR ENLARGERS

Note. Dimension *a* is the distance in inches from the lens to the projection paper; dimension *b* is the distance from the lens to the negative.

Amount of enlargement	Focal length of lens in inches															
	3		3½		4		4½		5		5½		6		7	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
twice	9	4½	10½	5¼	12	6	13½	6¾	15	7½	16½	8¼	18	9	21	10½
3 times	12	4	14	4-2/3	16	5-1/3	18	6	20	6-2/3	22	7-1/3	24	8	28	9-1/3
4 "	15	3¾	17½	4⅜	20	5	22½	5-5/8	25	6¼	27½	6⅞	30	7½	35	8¾
5 "	18	3-3/5	21	4-1/5	24	4-4/5	27	5-2/5	30	6	33	6-3/5	36	7-1/5	42	8-2/5
6 "	21	3½	24½	4-1/12	28	4-2/3	31½	5¼	35	5-5/6	38½	6-5/12	42	7	49	8-1/6
7 "	24	3-3/7	28	4	32	4-4/7	36	5-1/7	40	5-5/7	44	6-2/7	48	6-6/7	56	8
8 "	27	3⅜	31½	3-15/16	36	4½	40½	5-1/16	45	5-5/8	49½	6-3/16	54	6¾	63	7⅞



Lens front and slide assembly. A flat spring is let into the "blade" of the slide to prevent slipping and keep the slide pushed to one side of the track so that the lens front will always remain parallel to the negative

The next thing to have bearing on the size of the negative house will be the flashed opal glass (obtainable from any camera supply company). This should be located from 1 to 2 in. from the negative. If closer than 1 in., there is a danger that some speck of dust may be in focus when the lens is stopped down. In addition, sufficient material must be allowed on the negative housing to make a good connection with the lamp house. The cross area of the negative housing should be larger than the bellows or camera to be used, because this seems to give more even lighting of the negative. The slot for the negative carrier is open at both ends, that for the opal glass only at one end (for cleaning and replacement).

The negative carrier is made like a picture frame, or a printing frame with rabbet deep enough to take the negative, with mask, sandwiched between two pieces of flawless glass.

The lamp house is a part that requires a little experimenting to assure even projection of light. If the enlarger projects a beam of light that is bright in its center and weakening towards its margins, the print will show the same characteristics. This must be avoided. The lamp house should be of the same cross area as the negative house, and it may have either a flat top or a reflector top. For the latter type some workers use an old auto headlight reflector, others an aluminum mixing bowl. The reflector used in the enlarger illustrated was spun on the lathe, being formed directly in the toppiece of the lamp house before assembly.

This choice of materials should not, however, lead one to assume that their use is unimportant. On the contrary, each will defeat its own purpose unless it is particularly adapted to the enlarger it is to be used in.

First, cut a hole in the center of the reflector large enough to admit the small end of the light globe—either a photoflood or a regular type lamp. With the bulb projecting through the reflector, screw it into the socket of an extension cord (so you are free to move it about). The light is turned on, and the reflector is held over a light-colored piece of card or paper at the distance the reflector will be from the opal diffusing glass in the completed enlarger. The card should be of the same dimensions as the opal glass. Now move the globe in and out in the reflector till the light appears to cover the card completely and evenly. This gives the correct location for the globe, so mark the measurement carefully on your sketch.

It will probably be necessary to solder a section of a tin can or an aluminum cup to the reflector to hold the socket in the proper position when building the lamp house. While this beam will not be entirely even, due to the "hot spot" from the globe itself, it will be good enough, as the opal glass will further diffuse the light.

Although instructions are given from time to time for the construction of bellows, it is difficult to get just the right materials and adhesives to make a really efficient one and preferable not to try to make this part. The bellows illustrated were picked up with part of an old camera in a second-hand store for twenty-five cents.

A focusing device such as a rack and pinion is a great aid when using the enlarger. The parts for it can be taken from an old studio camera, or a rack and pinion can be purchased from one of the stock gear companies, but the substitute illustrated, which works very well. A spindle is passed through two brackets fastened to the sliding lens front, and a small pulley is fastened on either side, outside the brackets. The spindle projects a little farther at the right side so that a knob can be attached for turning it. Then a piece of 30-lb. silk fishing line is passed once around each pulley and fixed at each end to stationary parts of the enlarger, as illustrated. As the spindle is turned by means of the knob, the sliding front moves smoothly up or down. All these parts were taken from a model-engineering set. The lens-holding front fixed to the slide in this case was taken off an old camera, but it can be easily duplicated by the woodworker.

To avoid damage to the enlarger (when erected vertically) from slipping down the main slide and to facilitate its use, it is well to counterbalance the entire enlarger assembly with cord, weights, and pulleys.

While the enlarger is best if fastened to a wall in the darkroom, it may, if you do your developing in the bathroom or kitchen, be made portable by fastening the slide to a baseboard.

A few general suggestions may be added to help in the practical work of building your enlarger:

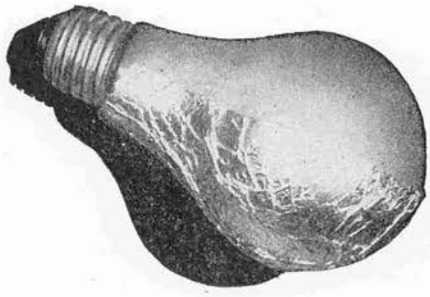
The lamp house is best made of tinned iron, because it is easy to work and reflects well. If it is more convenient to use some other metal, paint the inside with aluminum or white paint. The inside of all light-vent shields, the outside of the enlarger, and the inside of the negative house should be painted dead black, to avoid reflections. The negative house should be made from well-seasoned wood.

Avoid all possible light leaks, and shield vent holes inside and out. If there is still some light getting by, see that it is directed upward. The smallest leaks, if facing the sensitized paper, are dangerous. Place a strip of felt in the joints where the different sections of the enlarger come together.

See that the lamp house is well ventilated. This will lessen the danger of ruining a dense negative when prolonged exposure is necessary.

For governing the exposures, use a switch that is not rigidly connected to the enlarger; that is, a pendent or foot switch. This will prevent the setting up of vibrations when snapping the current on and off.

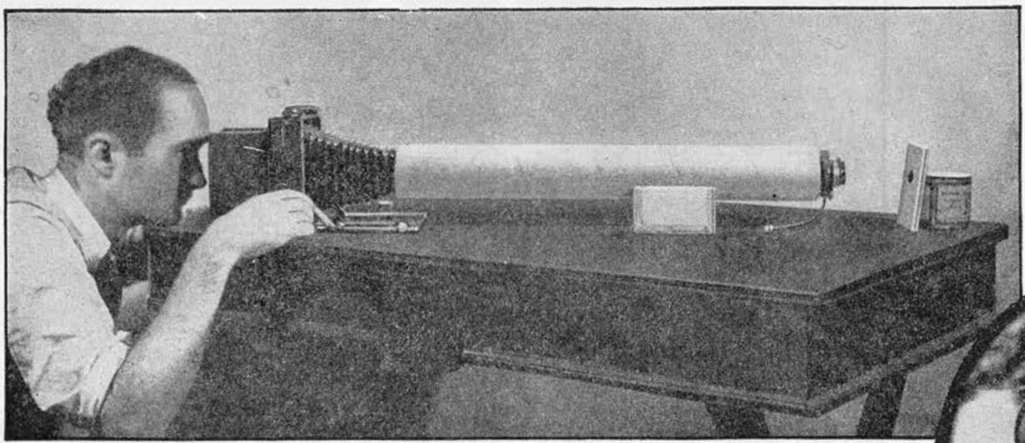
Lens, paper, and negative must be parallel. The only exception to this is when correcting verticals or distortion; in this case the lens is stopped down to obtain sufficient depth of focus to allow the sensitive paper to be tilted from its usual plane.



TIN-FOIL REFLECTORS FOR PHOTO LIGHTS

Darkroom lights may be improved by covering them as illustrated in the photograph above with tin foil glued in place with a little water glass or household cement. Lamps so treated will reflect an intensified illumination over what may be regarded as the safe portions of the room and throw a shadow over those areas of the darkroom where a continuous light, even a safe light, is dangerous to the film or paper.

Printing lights treated in the same way will cut your printing time to a surprising degree, as will a similar application to the light in a horizontal enlarger. Likewise, if you cover one half of your photoflood lamps in this manner, you will be able to dispense with reflectors, several of which would otherwise be necessary, especially if you do home portrait work. Be very careful, however, that the tin foil is cut short at the bottom and does not come in contact with the brass end of the lamp.



With only your camera and a cardboard tube, you can take

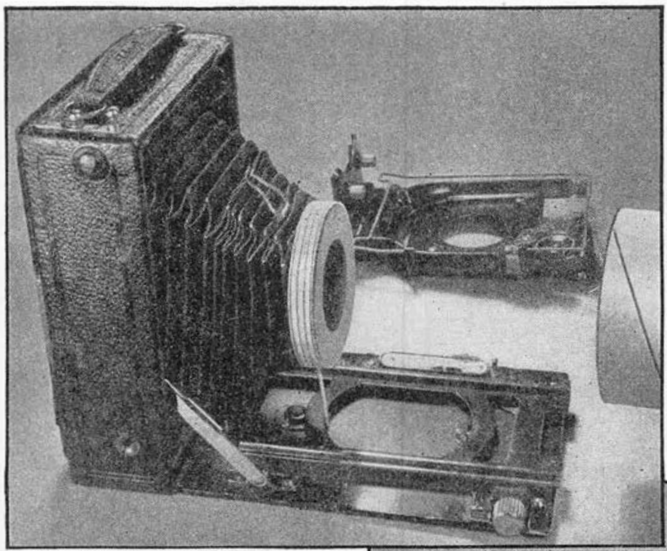
Striking Photomicrographs

EVEN without a microscope, you can make really good photomicrographs of tiny objects and organisms up to forty-six or more diameters. Of course, if you own a microscope, it will aid in selecting subjects suitable for photographing.

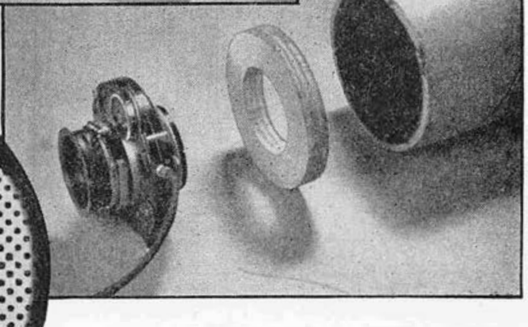
The method is much easier and simpler than the standard one of photographing through a microscope. You will need a small hand camera with a good lens and focusing (ground-glass) back, which can perhaps be borrowed if not already available. A larger camera can also be used, but if your camera is of the roll-film type, it must first be fitted up so that a piece of ground glass can be used for focusing at the back and so that a holder for cut film, film packs, or plates can be attached. Then you will need an auxiliary lens of the type sold for copying, which costs less than a dollar and slips over the front of the regular lens; a cardboard mailing tube about 24 in. long and of as large diameter as possible; several small pieces of plywood, some blackboard paint (or a dead-black mixture of shellac and lampblack), and a C-clamp.

Find the exact inside diameter of the mailing tube and cut two plywood disks to fit snugly. Next unscrew the lens and shutter from the camera. If your camera is of the type having an upright support for the shutter, the support is disengaged from the camera bed and laid aside. On the back of the shutter will be found a lens barrel that projects slightly, and perhaps a threaded bushing. At any rate, make a hole in the exact center of one of the disks to receive the rear barrel or bushing of the shutter. It should be a tight fit.

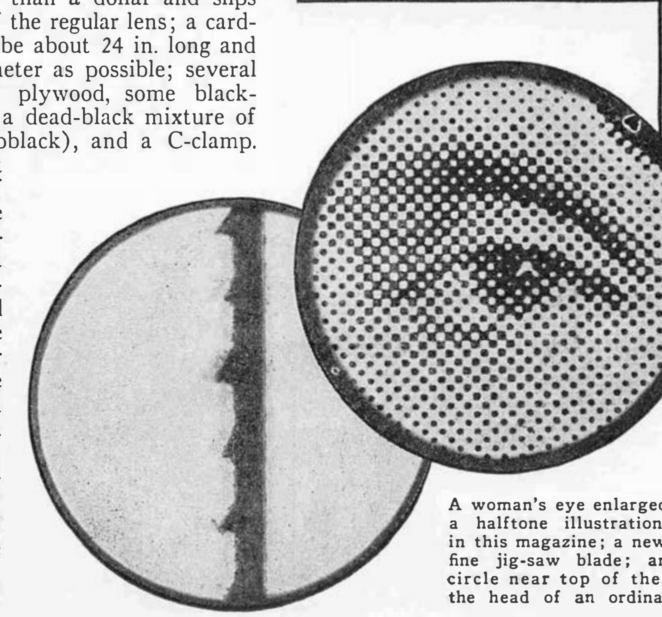
You will find that the mouth of the camera bellows has a metal plate. A hole the same size as the one in the plate is made in the other plywood disk, which is screwed in place as shown in one of the photographs. Mix up the blackboard paint or lampblack mixture thoroughly



After the lens and shutter assembly have been removed from the camera, a plywood disk is screwed to the metal plate at the mouth of the bellows, as shown at the left. The tube fits on this



The lens is mounted in another disk, as shown below, and the disk is inserted in the other end of the tube. The whole set-up appears at the top of the page, except the photoflood lamps used for illumination



A woman's eye enlarged from a halftone illustration used in this magazine; a new, very fine jig-saw blade; and, in circle near top of the page, the head of an ordinary fly and with it coat the inside of the mailing tube. This may be done easily by holding one end to the light and painting with a brush tied to a long stick.

The outfit is then set up as shown at the top of page 279. A wooden cradle is used to support the mailing tube, and the camera bellows is drawn out most of its length. A good place to assemble the outfit is along the edge of a workbench. Be sure that all parts are steady and without possibility of vibration. Fasten the bed of the camera to the bench with a C-clamp.

The best mount for the specimens to be photographed is a box about 5 in. square with one side painted dead black, or a miniature easel may be made. In any event the surface must be all black. A light-colored specimen may be mounted directly on this surface; to mount a dark specimen, first fix it to a bit of white cardboard no larger than a ½-in. square, which is, in turn, cemented to the black surface. A dab of water glass is a good cement for this purpose because it dries immediately. If the specimen is prepared on a slide for viewing by transmitted light, cover all but the middle of the slide with black paper and mount it over a hole drilled in the black mounting surface. The light can then be placed in the rear.

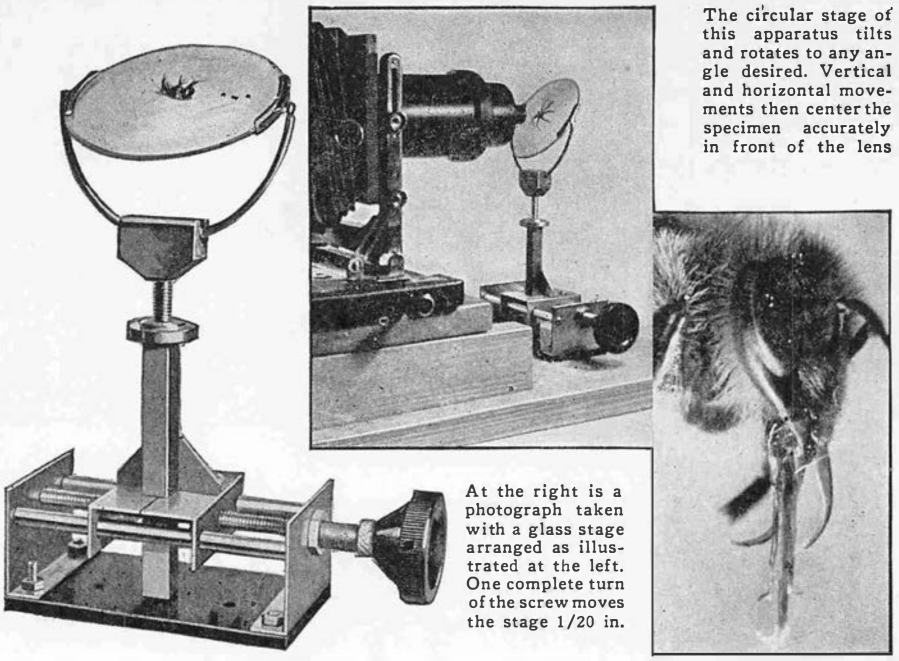
The specimen is first focused roughly with the lens wide open by either moving the tube back and forth or placing the mount nearer or farther away. Use a photo-flood lamp in a reflector at each side and slightly in front of the mount. When the focus is found, close the lens down to F/32 and make the exposure. A rough guide for the latter: light objects, from 5 to 10 seconds; medium, 30 seconds; and dark, such as the head of a fly, 1½ minutes.

With an outfit of this kind, a magnification of about twelve diameters is obtained. By placing the negative in an enlarger, clear prints showing an enlargement or magnification of forty-six diameters are easy to make; in fact, the negatives may easily be enlarged much more than this without loss of detail. The three sample photomicrographs were all taken with a 23-in. tube and are the actual negative size before further enlarging.

After the reader has seen how easy it is to make photomicrographs in this manner, however, he is advised to use a much longer mailing tube to separate the lens from the camera. Magnification will increase tremendously with the addition of several inches. The exposure must be lengthened accordingly.

MAKING COLOR FILTERS FOR MICROSCOPE

Color filters are sometimes necessary in microscope work in order to bring out details of crystals or other subjects having depth. An inexpensive way to make suitable filters is to place colored cellophane between two slides and cement them together. Such filters are almost as satisfactory as those used professionally, and there is no appreciable difference on low powers. Red and green may be made first, and then other colors added later to complete the set. Another hint useful to the beginner is to place a piece of ground or opal glass under the subject slide when necessary for the purpose of insuring an even distribution of light.



The circular stage of this apparatus tilts and rotates to any angle desired. Vertical and horizontal movements then center the specimen accurately in front of the lens

At the right is a photograph taken with a glass stage arranged as illustrated at the left. One complete turn of the screw moves the stage 1/20 in.

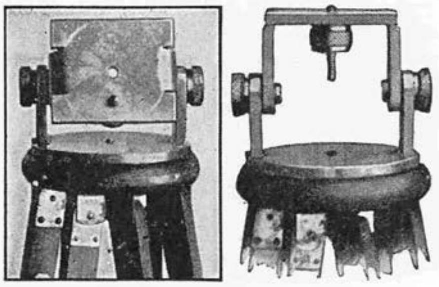
GLASS STAGE FOR PHOTOMICROGRAPHS

The amateur interested in photomicrographs will find this movable glass stage of great help in taking pictures. The circular stage tilts and rotates so that the specimen can be viewed from any angle. Centering is accomplished by vertical and horizontal movements. With the instrument illustrated, one complete turn of either adjusting screw moves the stage 1/20 in. which, when magnified ten diameters, is ½ in. on the ground glass.

Made from a ten-cent picture frame, the stage and its holder are mounted on a short screw set into a piece of square brass rod, which is an easy sliding fit in a square brass tube attached to the horizontal carriage. The base can be made from scraps of brass angles, rods, and radio parts.

The dimensions are not critical because a movement of more than 1 or 2 in. is not necessary, although the vertical rise can be more to suit various lens heights. A simple track mount for keeping the camera in line with the stage is a help.

TILTING HEAD FOR CAMERA TRIPOD

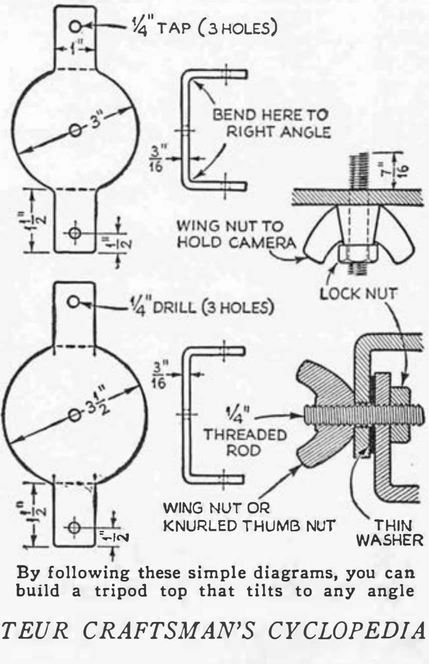


Any standard camera tripod enables the camera to be swung in a circle, but to tilt the camera, it becomes necessary to change the set of the legs, or to shorten one leg. Often this is difficult to do, and it always takes time. The tripod top shown here, however, is cheap and easy to make, and enables the user to swing the camera and tilt it to any angle, even to points straight up and down. This feature is especially useful in making "trick" shots, and with a home movie camera.

A piece of sheet aluminum about 3/16 by 3½ by 12 in. will make the frame. Either wing nuts or knurled thumb nuts may be used to pivot the head and lock it in any desired position. Wing nuts and a piece of threaded rod (¼-in., for most cameras) may be obtained in almost any hardware store. To make the movement of the head smooth, it is a good idea to place a fiber or cardboard washer between its two parts.

Most of the materials for this tilting top can be found in the junk pile, but even if they all have to be purchased, the cost will be very low.

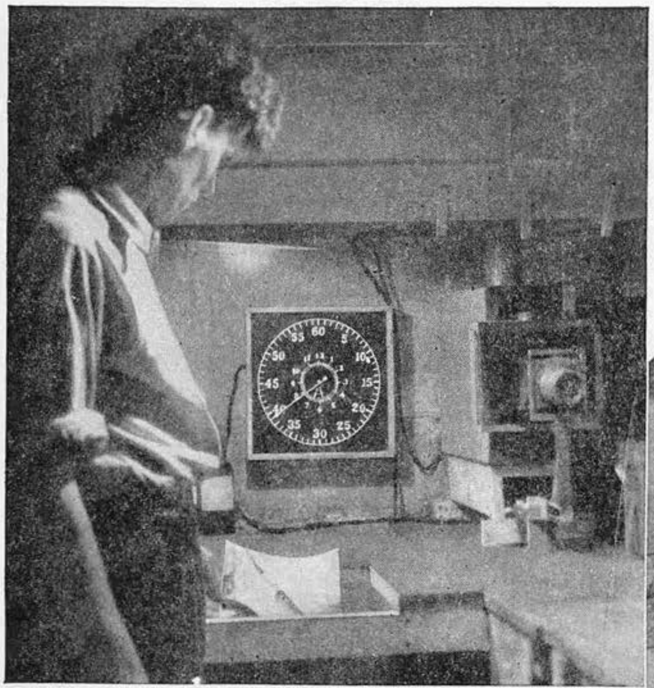
A standard ball-and-socket joint can, of course, be purchased to do the same work as this homemade tilt top, but such accessories cost money, and many of those available are unsuitable for any but a light camera.



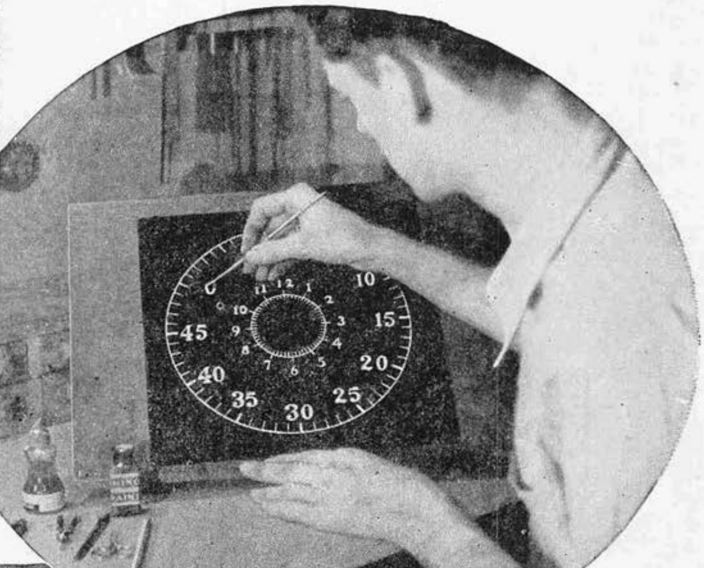
By following these simple diagrams, you can build a tripod top that tilts to any angle

Homemade Darkroom Clock

HAS LARGE DIAL MARKED WITH LUMINOUS PAINT FOR READING AT A DISTANCE . . . WILL NOT FOG SUPERSENSITIVE FILMS



Because of the size of the dial and the arrangement of the hands, the clock can be read from any distance up to 5 ft. in total darkness. The longest hand indicates the seconds



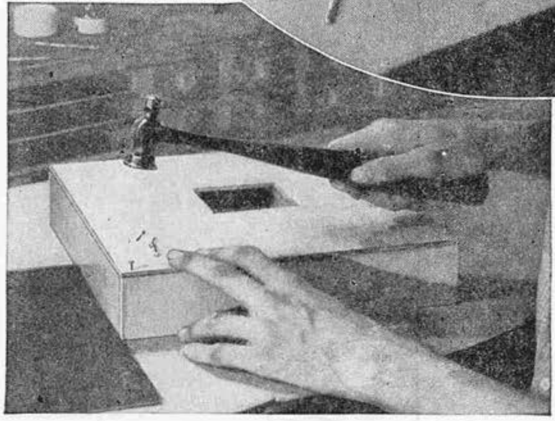
HERE is a luminous darkroom clock that will not fog high-speed film, yet it can be read approximately 5 ft. away in complete darkness. It can be used for timing either film development or the exposure of enlargements or contact prints.

The only parts required for making it are an inexpensive electric clock, a sheet of black Bristol board, a bottle of luminous paint, several calendars from which to cut suitable figures, and a few miscellaneous items such as solder and a small piece of thin sheet aluminum. If a thin enough sheet of aluminum cannot easily be obtained, you may use a heavy candy wrapper of the aluminum-foil type. This will be heavy enough.

Cut the Bristol board 12 in. square. With a pair of dividers or compasses, draw two circles, one 10 in. in diameter, the other 3 in. Divide both these circles into sixty equal sections. Make ⅜-in. long marks for the seconds on the 10-in. circle; and for ease in reading, double the thickness of every fifth mark. On the 3-in. circle make the minute marks ¼ in. long, and every fifth mark ½ in. long, as shown. To paint them, use a draftsman's ruling pen filled with luminous paint between the nibs instead of ink.

Cut figures about 1 in. high from a calendar to read from 5 to 60. Also prepare another set of figures about ½ in. high to read from 1 to 12. Glue them in position on the dial and give them one heavy coat of luminous paint. This will make the figures stand out slightly in an embossed effect, and they will be much easier to read.

Remove the case from the clock and pull off the hands with a pair of pliers. Remove the face from the motor by filing off the rivet heads.



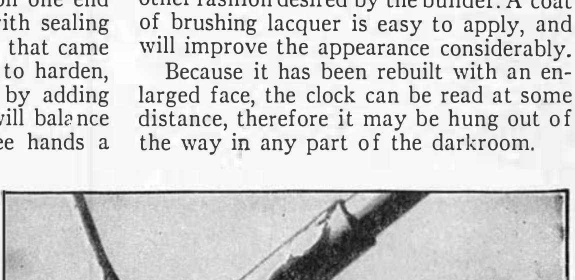
A frame 12 in. square is made and covered with a piece of plywood which has an opening to receive the clock motor

Make the extension for the second hand out of the sheet aluminum. Roll one end to form a round tube, fill it with sealing wax, and insert the second hand that came with the clock. Allow the wax to harden, then balance the second hand by adding solder on the short end till it will balance on a small nail. Give all three hands a coat of luminous paint.

Drill a hole in the center of the new face and three or four holes for bolting the motor to the face. Bolt it on with No. 6-32 machine screws. Construct a wooden frame 12 in. square and tack onto it a piece of plywood with an opening in the center for the clock motor. Glue the face to this piece of plywood, and put on the hands by pressing them carefully and accurately in place with the pliers.

Cut four pieces of wood ½ by ⅜ by 12 in. long, with the ends on a 45-deg. angle. On the ½-in. face of each strip, cut a saw slot 1/16 in. from the edge and wide enough to allow single strength glass to enter. Nail three strips on the face around the edge, cut a section of single strength glass 11¼ in. square, and slide it down the saw slots in the proper position. Then nail on the remaining strip. The frame and cover of the clock may be finished by painting, staining, or in any other fashion desired by the builder. A coat of brushing lacquer is easy to apply, and will improve the appearance considerably.

Because it has been rebuilt with an enlarged face, the clock can be read at some distance, therefore it may be hung out of the way in any part of the darkroom.



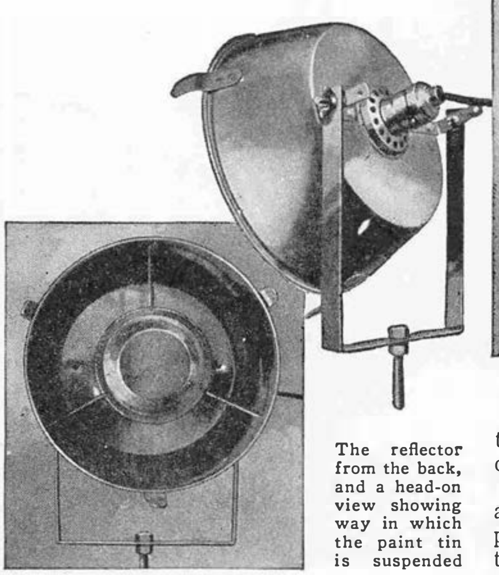
The second hand is extended by a tube of sheet aluminum filled with sealing wax. It is then balanced with solder

Cake-Tin Reflector
Gives Concentrated Light for
INDOOR PHOTOGRAPHY

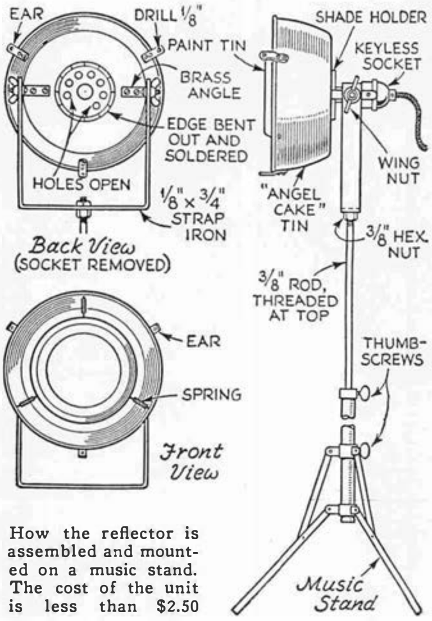
Thumbscrews at the sides of the reflector enable it to be tilted up or down as required

ALTHOUGH it compares favorably in efficiency with many expensive reflectors, this homemade photoflood reflector for indoor photography can be built for less than $2.50. It is easily assembled, does not throw a blast of heat, and directs the light where wanted. The necessary materials consist of a so-called "angel-cake" tin and a paint tin of the type illustrated, both from the ten-cent store; an old music stand bought in a junk shop (or a cheap new stand); and strap iron and angles from the hardware store.

For the main reflector, get a good angel-cake tin, preferably one of sheet iron plated with tin. Remove the conical central cone by grasping the core near the seam with a pair of pliers and twisting toward the seam. The core will pull loose from the bottom and come out without scarring the bottom. This will leave a hole slightly larger than a standard socket.



The reflector from the back, and a head-on view showing way in which the paint tin is suspended



How the reflector is assembled and mounted on a music stand. The cost of the unit is less than $2.50

Obtain a lamp-shade holder of the kind stamped out of one piece of metal. Bend the lower rim outward until it is parallel with the top. Center the shade holder over the hole in the cake tin, pin it securely in several places, and apply solder. Pins are necessary because photoflood lamps give enough heat to weaken solder.

At three places on the front rim of the cake tin, preferably opposite the three projecting ears, drill ⅛-in. holes for the springs which hold the secondary reflector in place. This reflector is made of a paint tin about 4½ in. in diameter, with three holes drilled in the rim about 120 deg. apart.

Screw a keyless socket into the reflector, and attach a cord and plug. Then screw a photoflood bulb into the socket. Suspend the secondary reflector with springs over the center of the bulb and as close as possible without touching it.

Mountings for this reflector can be made to suit the materials available. The reflector illustrated has two brass angles screwed to opposite sides of the back. These angles fit into a U-shaped piece of strap iron, and thumbscrews at the joint allow the reflector to be rotated vertically. The strap iron is fastened to a ⅜-in. iron rod, which fits the music stand.

Small holes drilled in the ears of the cake tin allow the secondary reflector to be placed farther away from the bulb when it is desired to increase the side light and decrease the front light. This also enables the secondary reflector to be used with a larger (No. 4) photoflood bulb.

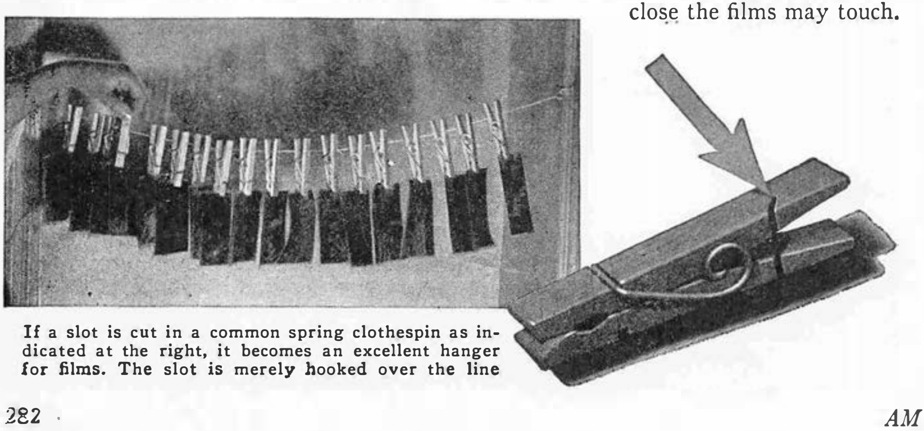
A diffuser, made of tracing cloth stretched in a 10-in. embroidery hoop, may be held between the ears when necessary. Three roundheaded wood screws evenly spaced about the circumference allow the diffuser to be snapped into the front of the reflector.

The light distribution of this reflector was measured with a foot-candle meter. With a No. 1 photoflood in the reflector, the light intensity directly in front of the reflector and 5 ft. from the center of the bulb, with the small reflector in place, was found to be 150 foot candles. Fifteen degrees away from the center line, at the same distance, the intensity was 100 foot candles, and 30 deg. off center it was 40 foot candles. With the small reflector removed, the intensity at the same distance directly in front of the reflector was only 140 candles; at 15 deg. off center, 100 foot candles; and at 30 deg. off center, 80 foot candles. Moving the small reflector away from the bulb decreased the front light and increased the side light, the total radiation, of course, staying the same.

A pair of units like this will make possible a great variety of lighting effects.

IMPROVED CLOTHESPIN FILM HANGERS

A SINGLE saw cut transforms the common variety of spring wooden clip or clothespin into an excellent hanger for drying films. One of the accompanying photographs shows the correct angle and location of the slot. These slotted hangers have a distinct advantage over the type having a hook attached to one side, in that the films hang parallel to one another. Be careful, however, not to place them so close the films may touch.

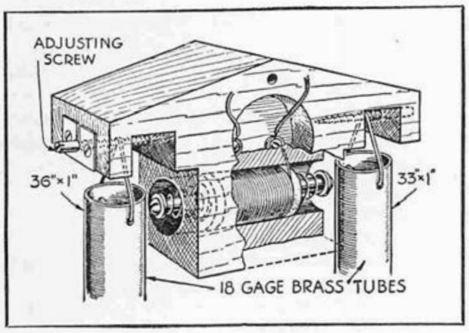


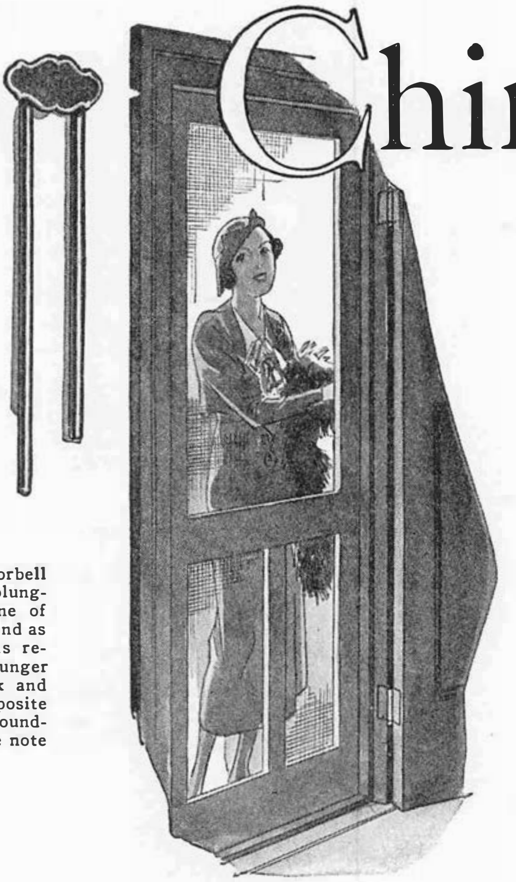
If a slot is cut in a common spring clothespin as indicated at the right, it becomes an excellent hanger for films. The slot is merely hooked over the line

ELECTRICITY and RADIO

How to Make a Set of Musical Electric Chimes

to replace your noisy old doorbell




When the doorbell is pushed, a plunger strikes one of the chimes, and as the button is released, the plunger springs back and hits the opposite chime, thus sounding a double note

IN MODERN homes, the harsh sound of the doorbell or buzzer is a discordant note that is both antiquated and unnecessary. It should give way to the soft, melodious, yet arresting tones of the chime. Although expensive to buy, suitable door chimes are easy to construct and the equal of those selling for many times their cost.

The body is cut from a block of wood 3¼ by 6 in. and approximately 2 in. thick. The finished thickness may vary a fraction of an inch either way from that shown in the drawing if the dimensions given in Fig. 2 of the working drawings are changed accordingly. To avoid splitting, select a piece of wood that is soft and of fairly close grain.

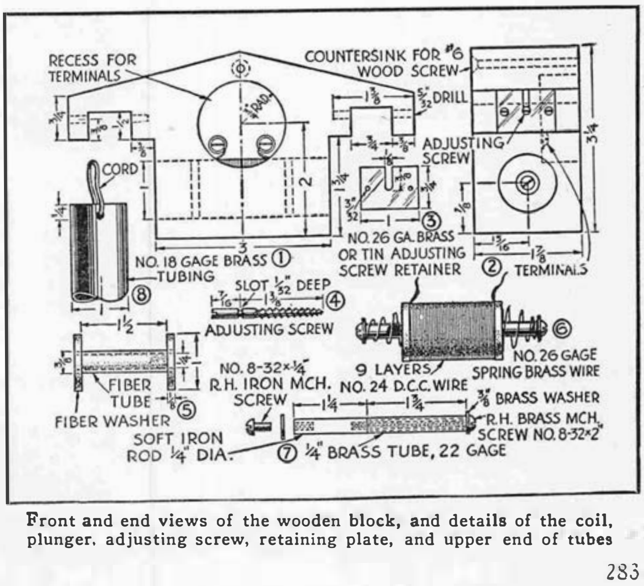
Cut the block to the shape shown in Fig. 1, and bore a 1-in. hole from end to end in the lower part to hold the coil. In the back of the block bore a recess 1½ in. in diameter and approximately ¾ in. deep to provide space for the terminal screws and surplus connecting wire. The lower part of the recess should break slightly into the hole provided for the coil, which will give sufficient space for the coil terminals to pass through.

At each end of the block, drill a 5/32-in. hole in the center to a depth of 1⅜ in. as shown in Fig. 1. This hole is for the adjusting screw, Fig. 4, which is made from a 2-in. No. 8 flathead wood screw. A circular slot, the inside diameter of which is ⅛ in., is cut in the screw as shown. The slot in the adjusting-screw retainer, Fig. 3, prevents the adjusting screw from moving out of place when adjustments are made. The screw retainer may be made of either tin or brass.

The adjusting screw and retainer are shown in place in Fig. 2, but the plate is not to be fastened permanently until the brass tube is suspended from the adjusting screw. The head may be removed from the adjusting screw and a slot cut in the end of the screw to give it a finished appearance, as shown in Fig. 4.

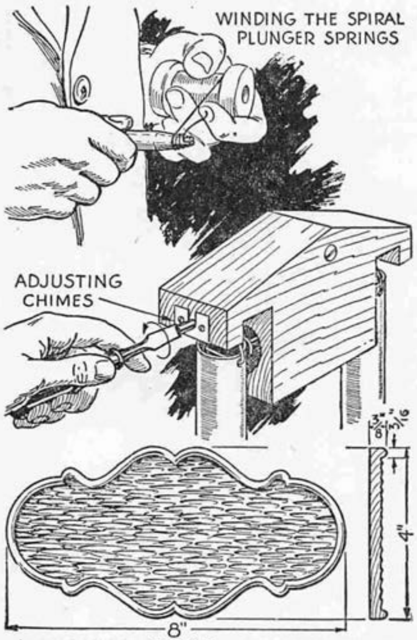
The form for the coil, Fig. 5, consists of a piece of fiber tubing ¼ in. in inside diameter, ⅜ in. in outside diameter, and 1¾ in. long, and two fiber washers 1 in. in diameter and ⅛ in. thick. The washers are drilled out to ⅜ in. and forced over the ends of the fiber tubing.

Wind the form full with No. 24 double cotton-covered wire. If the winding is done carefully, there will be room for nine layers or 480 turns. The winding must not extend over the width of the fiber washers, otherwise it will be impossible to force the coil into the hole



Front and end views of the wooden block, and details of the coil, plunger, adjusting screw, retaining plate, and upper end of tubes provided for it in the block. Approximately 2 oz. of wire will be required for the coil.

Force the coil into the 1-in. hole in the wood block so that the ends of the coil are the same distance from the outside edge of the hole. To hold the coil firmly in place, pour some shellac around it through the hole to the terminal recess. Secure the coil ends to the terminal screws, which are made from ½-in. No. 8 roundhead wood screws and small brass washers. These parts are shown in Fig. 1.


WINDING THE SPIRAL PLUNGER SPRINGS
ADJUSTING CHIMES
3/8"
3/16"
4"
8"
DECORATIVE FRONT COVERING BOARD

Method of winding the springs and adjusting the tubes, and a suggestion for a cover

The details of the plunger are shown in Fig. 7. It is essential that the dimensions be adhered to in making the plunger, also that brass and iron machine screws are used where shown. Although the plunger should not be inserted in the coil until after the coil is in place, an assembled view of the coil, plunger, and springs is given in Fig. 6 to indicate the correct assembly. The spiral springs are wound on a round piece of wood, tapering at the end from ½ to ¼ in., with a slot at the small end to hold the wire. Since the strength of the springs will depend upon the voltage of the transformer, it is advisable to make the springs with five or six turns and then cut away portions of turns until the correct adjustment is obtained. The illustration above shows the method of winding the springs on a tapered rod.

After the plunger has been inserted in the coil, the brass tubing should be suspended from the adjusting screw. The tubes forming the chimes consist of No. 18 seamless brass, 1 in. in diameter and 33 and 36 in. long respectively. While that combination gives a pleasing tone, there are almost limitless combinations that will be equally satisfactory. Gage, diameter, and length may all be varied to suit the builder's individual fancy.

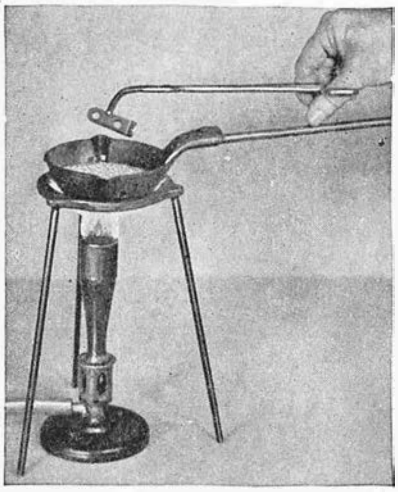
Loop a piece of heavy cord through holes in the tubing, as shown in Fig. 8, and hook it over the end of the adjusting screw which has been pushed through the 5/32-in. hole in the end of the block. Force the screw into the inside hole and secure in place by slipping the retaining plate over the circular slot in the screw. Fasten the plate to the block with small wood screws. If the retaining screw is now turned, it will be noticed that the cord will ride in the grooves on the screw, causing the tube to move either toward or away from the plunger. The complete unit may be permanently secured by means of a long wood screw after the circuit wires have been connected to the terminal screws.

The coil and plunger are designed to work satisfactorily on 10 volts, alternating current, but it will be necessary to provide a higher voltage if the bell-circuit wires are of small diameter or are unusually long. The standard type of doorbell transformer in common use everywhere is designed to give 10 volts, but for a few cents more—all doorbell transformers are very inexpensive—it is possible to obtain one that has several terminals, giving 6, 12, or 18 volts, as desired. It is, of course, entirely feasible to use batteries; ordinary dry cells will last a long time.

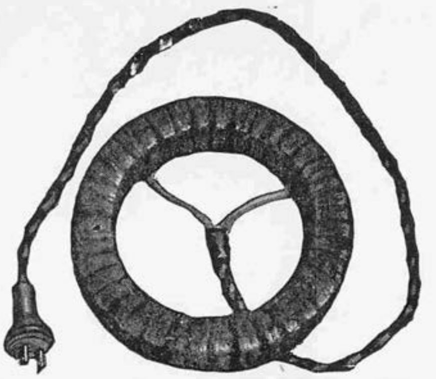
Plunger and tubes should be so adjusted that when the push button is pressed there will be one clear note sounded, and when the button is released another note will be sounded. If the plunger makes a vibrating sound instead of a single stroke, the tube is too close to the plunger. If the return stroke when the push button is released is sluggish, it will be necessary to increase the tension of the spring on the return stroke side.

If it is desired to cover the face of the unit, a plate may be cut from a piece of mahogany or other hardwood ⅜ or ½ in. thick, as shown, and finished with stain and shellac.

SOLDER COAT PROTECTS METAL FROM RUST



A USEFUL method of protecting any metal object except aluminum from rust is to give it a coating of solder or zinc. The solder or zinc can be heated in an iron ladle, and the part to be coated, after being thoroughly cleaned, is thrust into it. Several particles of zinc chloride or ammonium chloride (sal ammoniac) laid on top of the molten metal will serve as a flux. The object can also be dipped into "killed" acid or a solution of zinc chloride before it is thrust into the solder. After taking it from the molten bath, throw the object on the bench or floor so the excess metal will be removed by the impact.



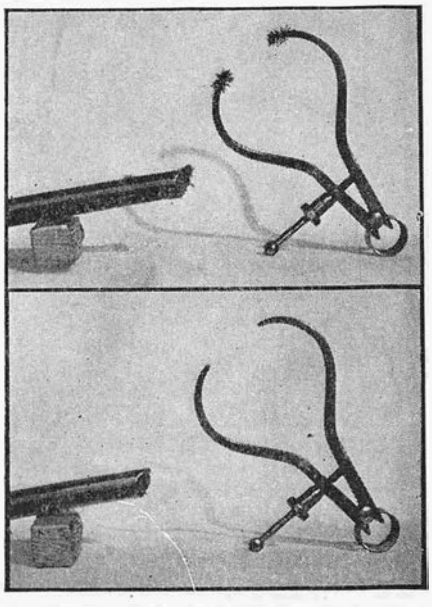
HOW TO DEMAGNETIZE TOOLS AND WATCHES

BUILDING the demagnetizer illustrated above will eliminate constant bother with magnetized lathe tools, drills, reamers, and other tools. These tend to hold the chips, often causing the tool to jump and mutilate the work.

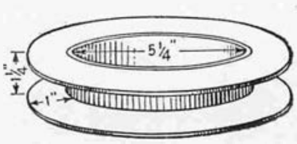
The materials required are 4 lb. No. 26 enameled magnet wire costing approximately $1.20; two 2-oz. rolls of ¾-in. cotton tape, 30 cents; and 6 ft. of rubber-covered portable cord made up with drop switch and attachment plug, 42 cents.

The wire is wound on a heavy cardboard form, consisting of two disks glued to a center ring. The tape may be wound over both form and wire. Wire of a gauge larger or smaller may be used and the insulation may be enamel or cotton.

Plug the coil into any 110-volt a. c. circuit and pass the object to be demagnetized slowly through the coil one or more times. If the object is a watch, hold the coil in a horizontal position, tie the watch to piece of string about a foot long, drop it through the center of the coil, snap on the switch and very slowly lift the watch up through the coil and a foot or so beyond before turning off current. This will not harm any watch.



Boring bar and calipers used on an electrically welded cylinder, and the same tools after they had been in the demagnetizer ten seconds



The form is a short cardboard tube and two disks of heavy cardboard or thin plywood

NEON TUBE

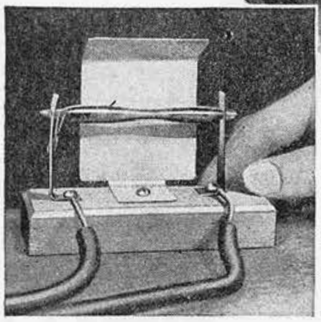
EXPERIMENTS

Weird Stunts Performed with Simple Apparatus

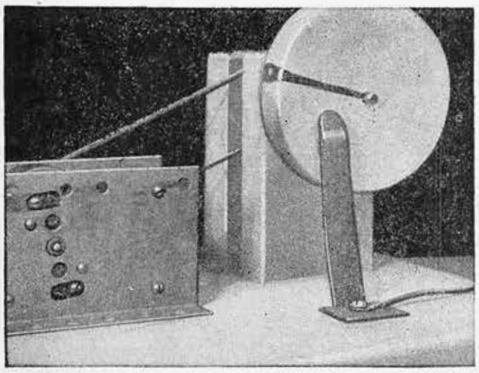
THE hand is said to be quicker than the eye, but a neon tube holds the real prize for speed. It can flicker on and off a hundred times while the eye blinks once! Because of this peculiar ability, many amazing experiments can be performed with it at practically no cost. A few of them will be described together with a home-built circuit breaker with which to do them. A storage battery or any other source of A. C. or D. C. current of from 6 to 12 volts may be used.

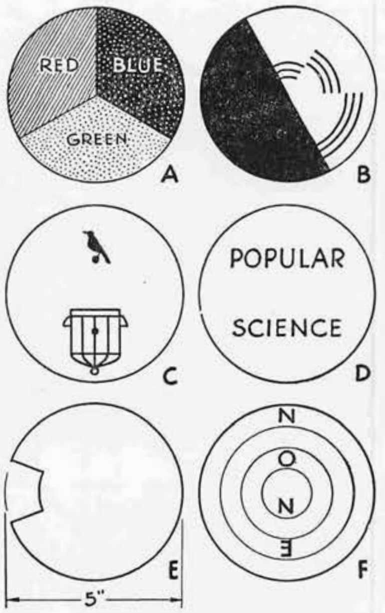
To illustrate how the apparatus works, a disk (*A*), consisting of the three fundamental colors, red, green, and blue, is attached to the shaft of apparatus. When it starts to spin, the colors vanish and the disk looks white, but in the fluctuating glow of the neon tube the colors become distinct and visible again, and the entire apparatus seems to stand still, although it is really spinning rapidly.

The details of construction are clearly shown and are, for the most part, self-explanatory. Run the apparatus at medium speed for best results. By using a toy-train transformer to supply current for the motor, the best speed can be found while the outfit is in operation. The vibrator spring on the Ford coil should be weak, and a little adjustment here will not be amiss. It is best to shut off the current while adjustments are being made.



An ordinary spark-plug tester furnishes the neon tube. It should be carefully removed and mounted on a suitable wooden base as shown at the left. The reflector should not be placed too close to the neon tube itself

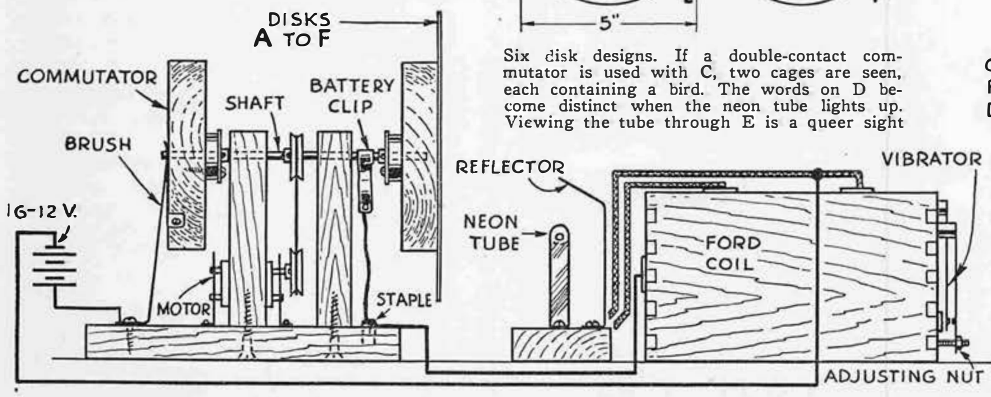




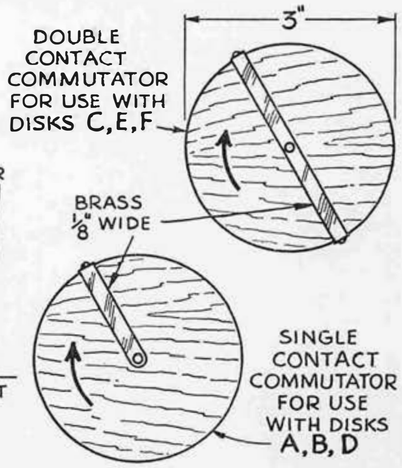
Six disk designs. If a double-contact commutator is used with C, two cages are seen, each containing a bird. The words on D become distinct when the neon tube lights up. Viewing the tube through E is a queer sight

Various disk designs are shown, and also a double contact commutator for use with disks *C*, *E*, and *F*. Disk *B* produces a very unusual effect. Note that the disk itself is drawn in black and white only. As it spins under ordinary lighting, it will seem colored, but no two persons will see the same colors. Now bring the neon tube near the disk and the colors will disappear, to be replaced by the design, clearly seen although the disk is still swiftly moving. The effect can be made more dramatic by performing the experiment in a darkened room lighted only by the red glow of the neon tube. Shine a flash light on the whirling disk at intervals.

The scramble of letters on disk *F* is unscrambled with the aid of the tube and a word is spelled with which you are by now familiar. Disk *F* must be used with the double contact commutator.



A toy construction set supplied the original parts. The base is ½ by 6 by 9 in.; the uprights are ½ by 2 by 3½ in. The brush is of spring brass. Note that the shaft itself forms a part of the circuit


3"
DOUBLE CONTACT COMMUTATOR FOR USE WITH DISKS C,E,F
BRASS 1/8" WIDE
SINGLE CONTACT COMMUTATOR FOR USE WITH DISKS A,B,D

Sensitive Electric Eye

Magical little device will operate a photographic exposure meter or automatic garage-door opener . . . It will guard rooms, turn on lights, and do many stunts

WORKMEN passing between the sun and a bank of copper oxide rectifier disks were responsible for the discovery of a new, dry disk type of photocell or so-called "electric eye." It was found that light falling on a disk of copper covered with cuprous oxide was converted directly into an electric current.

After a great many experiments the electronic dry disk cell was improved until it is now used for measuring room light in tests to prevent eyestrain, for photographic exposure meters that function automatically, and for various counting operations in manufacturing plants. One inventor even went so far as to connect a sufficient number of the cells to supply enough power to run a small electric motor for demonstration purposes.

The electronic cell requires no outside current for operation and there are no liquids to spill or glass bulbs to break. One of the cells can be housed in a casing the size of a pocket watch, and carried as easily.

The manufactured cells of this type will give a current of over 5 milliamperes in daylight. The efficiency of a homemade cell depends on the care with which it is constructed, but is sufficient to operate a sensitive relay. It can be used for turning on the lights in a room when it becomes dark outside, opening garage doors, ringing bells when a beam of light is interrupted and other practical applications. For measuring light it is connected directly to a sensitive meter, such as a direct-current milliammeter or microammeter, and a special dial is calibrated for the purpose.

For making the disks, you will need pure sheet copper, 1/32 in. thick. Most sheet copper is electrolytically refined and sufficiently pure; or you can make use of the copper of a halftone "cut" or engraving. The amount of current generated depends on the size of the disk; the one illustrated has a diameter of 2¼ in., but smaller sizes can be used satisfactorily. Leave a lip on the edge so that it can be grasped with pliers (Fig. 1). In order to carry out subsequent operations successfully, it is absolutely necessary that the surface of the copper be smooth and clean. After polishing it, dip the disk in water, flow it with nitric acid until clean, then rinse in water and dry with a clean cloth.

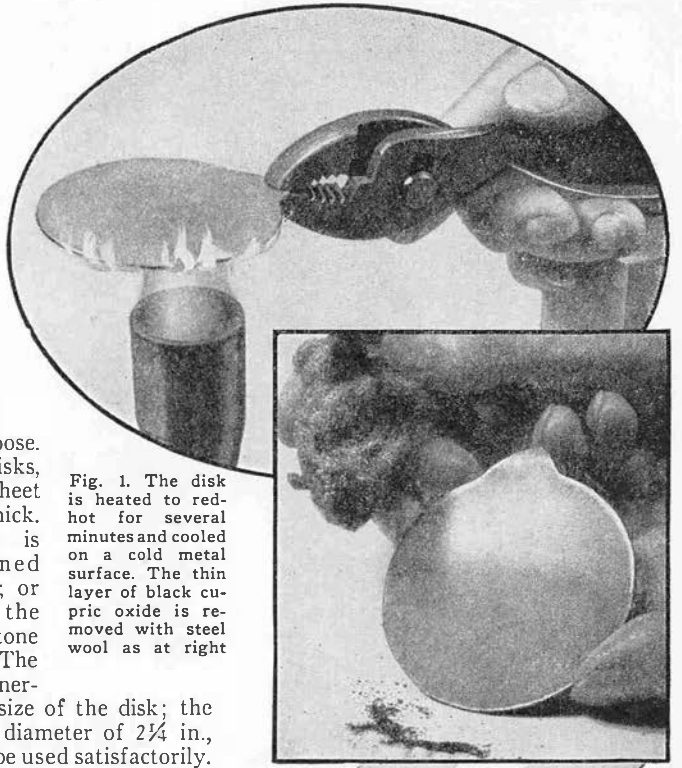


Fig. 1. The disk is heated to red-hot for several minutes and cooled on a cold metal surface. The thin layer of black cupric oxide is removed with steel wool as at right

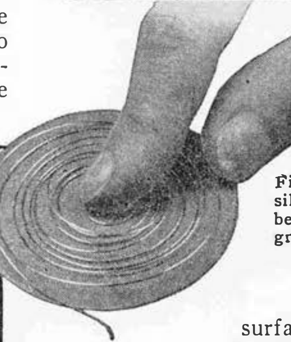


Fig. 2. A spiral of silver-plated wire may be used as a connecting grid on the red oxide

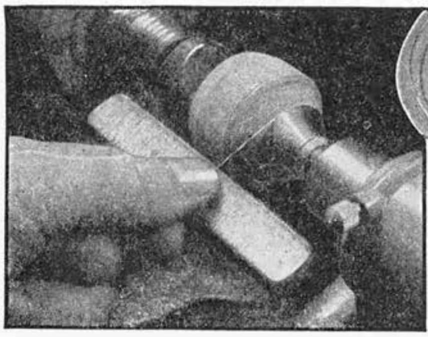
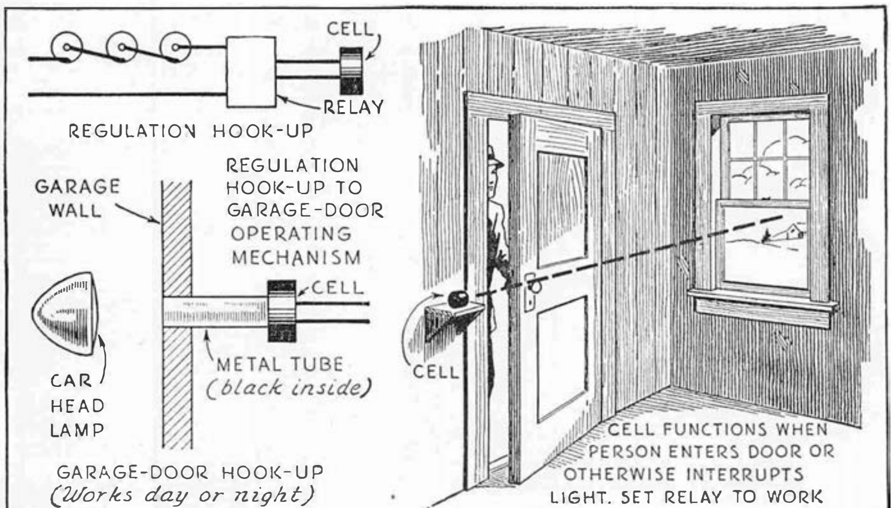


Fig. 3. An easy way to form the spiral grid is to wind the wire on a wooden cone as shown at left

Cuprous (copper) oxide is formed on the disk by subjecting it to a red heat for several minutes over a Bunsen burner, as shown in Fig. 1. An alternative method is to use an electric or gas furnace, when such advanced equipment is available, but in any case the air must have free access to the copper. In using the Bunsen burner, move the disk about so that all parts will be evenly heated, then lay it on a cold metal surface (such as a heavy steel saw table) to cool. The outer surface will be covered with a thin layer of black cupric oxide. Due to the difference in contraction, the black oxide will usually loosen itself from the surface by this cooling method and can be readily brushed off with fine steel wool.

If you have difficulty in removing the black oxide in this manner, it can be removed with a solvent. The operation is rather delicate. Either dilute nitric acid or a very weak solution of sodium cyanide


CELL
RELAY
REGULATION HOOK-UP
GARAGE WALL
REGULATION HOOK-UP TO GARAGE-DOOR OPERATING MECHANISM
CELL
METAL TUBE (black inside)
CAR HEAD LAMP
GARAGE-DOOR HOOK-UP (Works day or night)
CELL
CELL FUNCTIONS WHEN PERSON ENTERS DOOR OR OTHERWISE INTERRUPTS LIGHT. SET RELAY TO WORK WHEN CELL CURRENT IS INTERRUPTED

Made *from a* Copper Disk

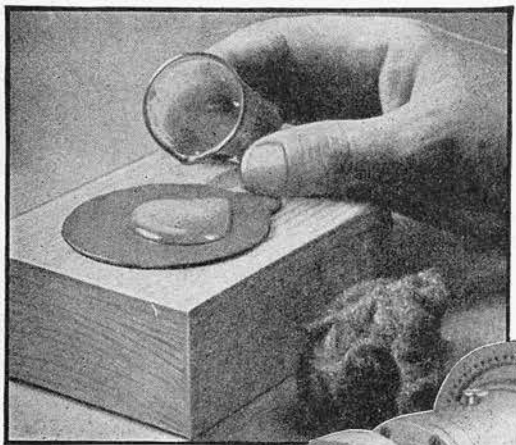


Fig. 4. The silver solution is flowed on

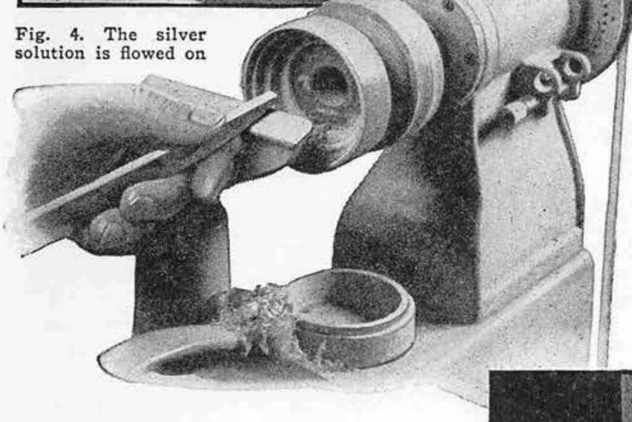


Fig. 5. That half of the wooden box for housing the photometer must be turned in a series of steps. A full-size drawing is given below

may be used. In careless hands either of these may eat through to the mother copper underneath, in which case the heat treatment must be repeated. In using sodium cyanide, remember that it is a dangerous poison and that it must not be mixed with an acid because of the deadly fumes that would be generated.

BE very careful not to remove the layer of red material, which is the photoactive cuprous oxide and lies immediately under the black oxide film. If the red oxide becomes scratched or worn through to the copper underneath, the disk must be cleaned and reheated, otherwise it would short-circuit the finished cell and a current would not be produced. Usually the extreme edge of the disk will lack the red oxide coating, so the coat of silver or the wire grid, which is to be applied next, is not allowed to reach the edge.

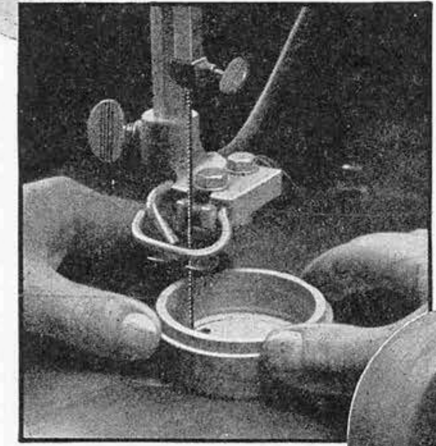
Held in the light, the cell will now generate a current between the oxide and the copper, the latter being positive and the oxide negative. So that the current may be usable, connections must be made. The back of the disc can be cleaned with emery paper for the one connection, but making contact with the oxide is a more delicate proposition. If a good connection is not made, contact resistance will be so high that all of the current will be used up before it has a chance to register at the sensitive meter. A good connection can be made by partly covering the surface of the oxide with a grid, which can be a coil of silver-plated wire or a coating of pure silver that is so thin as to be partially transparent.

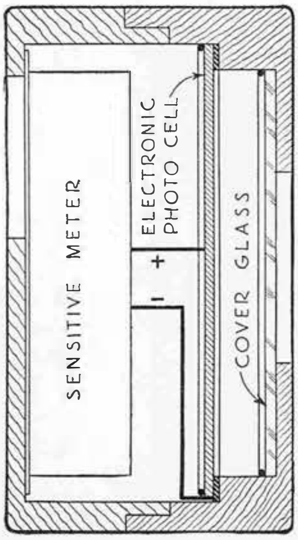
The wire grid is less efficient, but easier to apply. Use 30-gauge wire, forming it into a spiral to cover the oxide (Fig. 2) and holding it in tight contact by means of a cover glass. Allow one end to project from under the glass for making a connection, but see that it does not touch bare copper. A good way to make the grid is to wind the wire on a wood cone, as shown in Fig. 3.

Coating the oxide with a film of silver is a more delicate operation, but it gives most satisfactory operation. It is done commercially by sputtering the silver over the oxide, in a vacuum; you can do it chemically by pouring a special silvering solution over the oxide, allowing the silver to precipitate, and then gently washing and drying. Level the disk when flowing it with the solution, so that the latter will form a circular pool as in Fig. 4.

USE distilled water for the solution. Make up ten-percent solutions of ammonia water, caustic potash and Rochelle salt. In 1 oz. water dissolve a crystal of silver nitrate the size of a match head, and add drops of ammonia solution until it becomes almost clear after first turning brown. If you were to use undiluted ammonia the change would be so rapid as to be unnoticed. Next add a drop of potash solution, then more ammonia until it is almost clear again. The solution should be slightly cloudy; if too much ammonia is used, it will dissolve away the cuprous oxide on the disk and cause a short circuit so that the cell could not possibly function. Stir in one drop of the Rochelle salt solution and use immediately.

The time required for the silver to become precipitated depends on the temperature and other factors, but a visual examination will show when the operation is completed. The film of silver should be very thin, and when gently polished the disk should have a silvery color through which the red oxide shows through very slightly. Contact can be made to this surface with a metal ring (silver-plated copper, or lead) of slightly less diameter than the disk. It is advisible to give both the contact ring and the face of the disk a coating of thin lacquer, but do not allow the lacquer to come between the ring and the silvered surface and spoil the contact. The cell is housed in a turned wood box made as shown in Fig. 5.





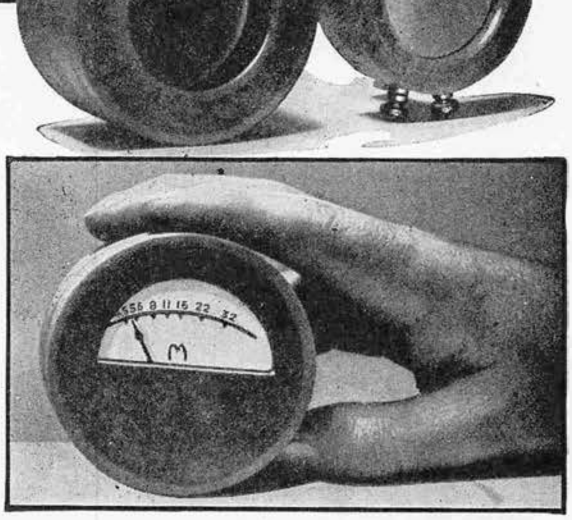


Fig. 6. A group of views of the photometer. The dial is calibrated to give the correct stop for a 1/25-second exposure

In using the cell as a photometer, the sensitive meter and the electronic disk are housed in the same container, as shown in the drawing of the group of illustrations marked Fig. 6. The half of the box holding the cell is turned in steps, as in Fig. 5, in order that the disk may be set back from a light opening of smaller diameter. This is to limit the light entering the box so that only the light reflected from the scene to be photographed can affect the cell. One of the illustrations shows how an opening is cut in the other half of the box for the meter scale; hold the box on the saw table with your hands, and with the regular hold-down out of the way. Both the front of the photometer and the meter side are shown in Fig. 6.

A specially calibrated scale must be attached over the regular meter scale. It can be accurately calibrated from an outdoor scene requiring a known exposure, such as 1/25 second at F/16. Train the cell side of the meter on such a scene, tilting it slightly downwards so as not to include too much sky. Make a pencil mark on the scale where the pointer rests and mark it "16." Then take the meter indoors and train it on a large sheet of white cardboard illuminated with a photoflood lamp in a reflector. Move the lamp nearer or farther away from the cardboard, until the reflected light causes the meter pointer to rest at the pencil mark. By folding the cardboard in half, half as much light will be reflected and the pointer will rest at the next larger stop position. By using twice as much cardboard, the next smaller stop position will be indicated. In this way, pointer positions for each stop at 1/25 second can readily be found and marked on the scale. Stops for other speeds can be figured easily enough once the correct stop for 1/25 second is known.

IN order to have the doors of your garage open when the automobile head lamps throw light on a photo-electric cell, or to have room lights automatically turn on when it becomes dark outside, some means must be used to step up the power from the photocell circuit so that it will close a switch on the 110-volt house current line. The very feeble impulse must be magnified, as it were, so as to perform satisfactorily and instantly whatever task is required of the apparatus.

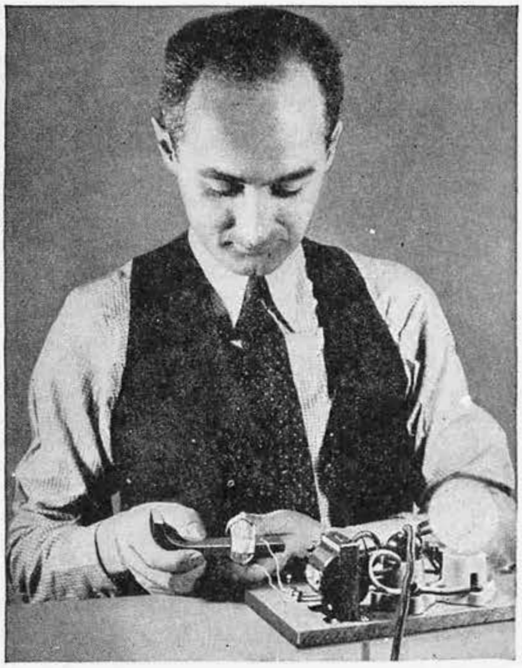
THE need for amplifying the power is especially evident in the case of these new electronic photocells. This is true whether they are of the commercial variety or are constructed at home by the method just described. Dry-disk cells of this type convert light directly into an electric current without the aid of outside power sources. Although this current is very small, on the order of milliamperes, the relay to be described is sufficiently sensitive to handle it effectively in making contact across both 10-volt alarm-bell and 110-volt power circuits.

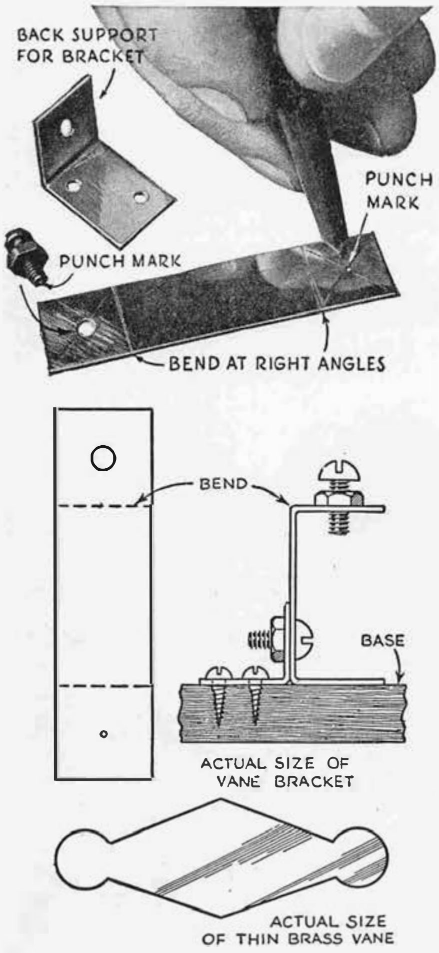
The parts required in the construction of the relay are simple—a doorbell transformer, two porcelain sockets, a bar magnet, and some odd pieces from the junk box. The weak photocell current is fed directly into a small solenoid coil mounted on a vane, which is delicately balanced so as to turn at the slightest effort.

One milliampere of current passing through the moving coil is sufficient to attract it to a permanent magnet, closing the contact across a 10-volt doorbell transformer circuit. This alone is enough for ringing a bell when a beam of light is interrupted. However, the transformer current in turn is made to close a 110-volt house current switch for the operation of small motors (for opening and closing doors or any similar purpose) and electric lights.

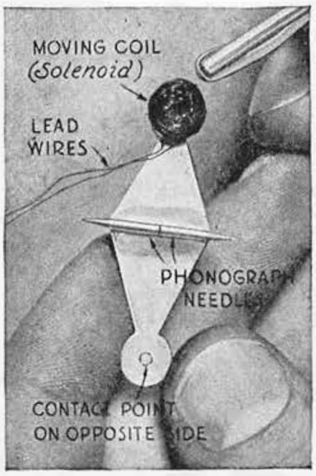
An idea as to the sensitivity of the relay can be had by attaching the leads from 200 turns of magnet wire to the binding posts where the photocell is ordinarily connected. Passing a bar magnet back and forth through the coil will produce enough current to actuate the relay and thus turn on a lamp in the 110-volt circuit. This striking demonstration of the efficiency of the relay is illustrated in the photograph at the top of this page.

Parts for the bracket that holds the moving coil vane can be made from sheet copper or brass, as shown in a photograph and in one of the drawings. The vane is cut from sheet brass of the thickness of bond writing paper. Two phonograph needles are soldered end to end at the middle (as indicated in the photographs below) for a balanced shaft. The top needle is held in a punch marking made in the end of a small screw

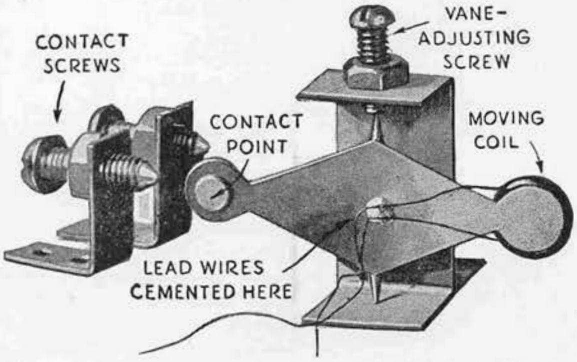


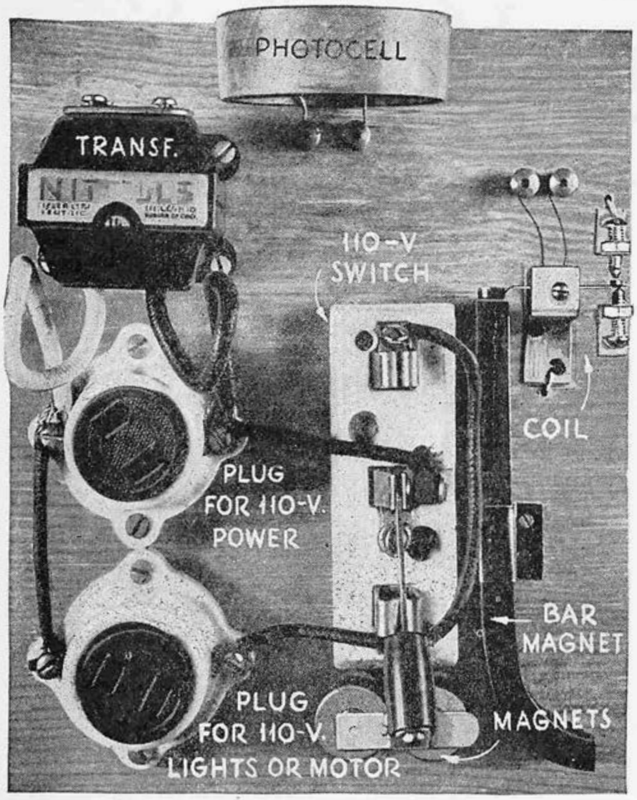


Patterns for vane and bracket, and how the bracket is drilled, indented, bent, and set up. The large photo at top shows an experiment to prove remarkable sensitivity of the relay

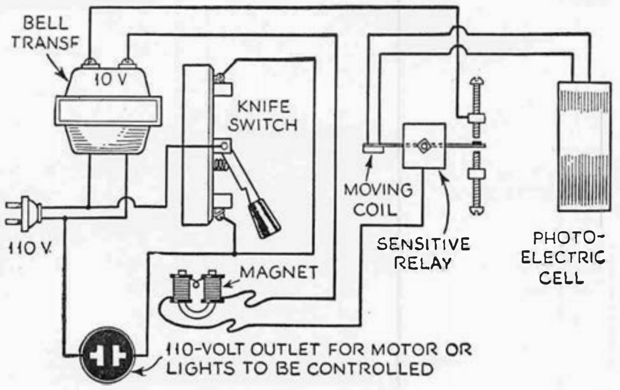


Left: Fastening coil to vane with cellulose cement. The shaft is made of two phonograph needles. *Below, at right:* The vane set up in the bracket





Top view of the completed relay unit mounted on a board 7 by 8½ in. The wiring diagram is given at the right. All 110-volt wires are above the board; the remainder, below it



passing through a nut soldered to the top of the bracket; the lower needle engages a similar punch mark in the lower part of the bracket. Solder a silver contact point (from an old doorbell or buzzer) to one end of the vane, and fasten the moving coil to the other end, on the opposite side, with celluloid cement.

IN the view of the completed vane and bracket, note that the coil wires are brought around to the opposite side and held at the middle with a drop of cement. From this position they lead to binding posts on the mounting board, but they also serve as tension springs against which the coil must pull in order to close the contact. These wires must be delicately adjusted to provide a very small resistance against the movement of the vane.

For the moving coil, No. 40 enameled copper wire is used. You can obtain this from the secondary of an old Ford spark coil. It has a resistance of about 1 ohm per foot, therefore the correct length of wire must be wound to provide the right amount of resistance for the type of photocell to be used. A selenium type cell will require considerable resistance to handle the higher voltage used in such a circuit. If you wish to operate the relay from an electronic (dry-disk) type of photocell, a coil of very low resistance must be used. From 3 to 10 ohms resistance is satisfactory.

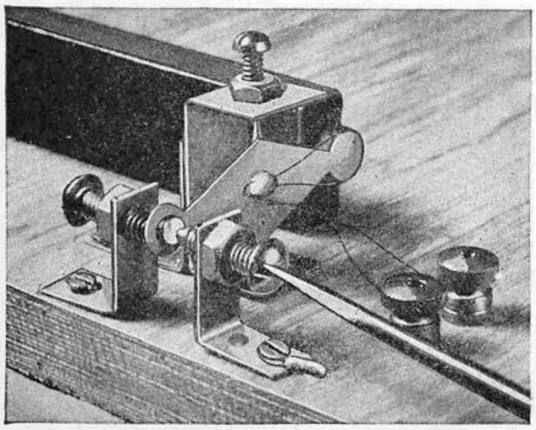
The winding used on the original relay shown in the photographs consisted of 5 ft. of wire, giving a resistance of 5 ohms. The wax coating was first removed by pulling the wire through a rag soaked in benzine, and then the wire was formed into a neat coil by wrapping it around the end of a ¼-in. drill shank. A little shellac will hold the coil in shape until it is cemented to the vane.

A photograph below shows how the coil is placed next to the end of a permanent bar magnet, with the lead wires connected permanently to binding posts. The contact screws are held in nuts soldered to small pieces of copper bent at right angles. The screw at the back is for adjusting the vane so that the coil is at the correct distance from the magnet, while the front screw has a silver contact point opposite the contact point on the vane. The 10-volt transformer circuit is completed through vane bracket and front contact screw bracket. These all require careful and delicate adjustment to be sensitive to a weak current passing in the moving coil, but once adjusted they need no further attention.

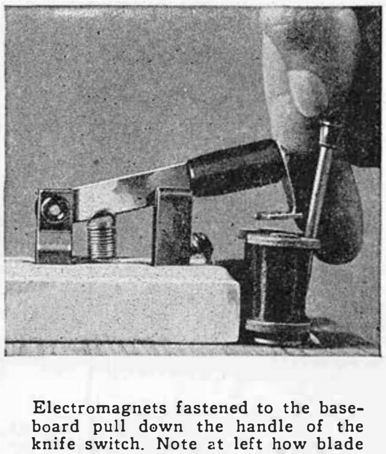
THE 110-volt circuit is closed by means of a single knife switch actuated by electromagnets from an old doorbell. These are fed, when the vane contacts close, from a 10-volt bell transformer. Two illustrations suggest how the knife switch may be altered. A weak spring keeps it in the open position until a bar of soft iron (also from a doorbell) attached to the handle is pulled down by the magnets.

As the relay is really a combination of a sensitive and a rugged relay, the two units may be mounted separately if desired. The sensitive relay, however, must be near the photocell if it is to receive all of the current generated by the latter. The view at the top of this page shows both relays mounted as a complete unit, with the photocell at the top, on a board 7 by 8½ in. The parts can be grouped on a much smaller board if there are space limitations. It will be noticed that all 110-volt wiring is above the board, while the remainder is placed underneath. The power line is plugged into the socket next the transformer, while the lights or motor to be operated by the relay are plugged into the other socket.

Being actuated by 10-volt alternating current, both magnets and knife switch must be adjusted to reduce the hum caused by alternating current, so as to avoid vibration of the moving vane.



***Left:* Careful adjustment of the front contact screw is required to make the relay supersensitive. The back screw governs space between coil and magnet**



Electromagnets fastened to the baseboard pull down the handle of the knife switch. Note at left how blade of knife switch is filed down to insure a clean make-and-break contact

Lifting Stunts

PERFORMED WITH ELECTRO-MAGNET AND FLASH-LIGHT CELL

Wrought-iron electromagnet supporting 250 lb. Note flash-light cell directly beneath the magnet. *Right:* Magnet holding a 50-lb. anvil

A STUNT that never fails to bring gasps of wonder from the layman is to connect a single pencil flash-light cell to a powerful homemade electromagnet and have it support the weight of two boys or men. Actually, the magnet will have the same lifting power and consume the amount of current regardless of the size of the dry cell, but the uninformed will usually associate a minute amount of electricity with a cell of such small proportions. The cell, of course, should be connected to the magnet only when actually in use as its current capacity is limited.

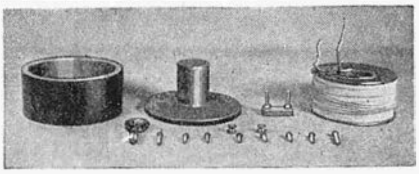
The magnet marked No. 2 in the drawings is capable of sustaining 250 lb. on a single flash-light cell. The current consumption is .6 ampere.

The shell is 4-in. black iron pipe, turned to a length of 2 in. in a lathe. It is essential that the ends be turned perfectly true. A wrought or soft iron plate ¼ in. thick and 4½ in. in diameter is drilled as shown, and corresponding holes are drilled in one end of the pipe, to which the plate is fastened with machine screws.

The core is a piece of soft iron, turned to size, drilled, and tapped as indicated. This is fastened to the top plate with an eyebolt, which is made from a piece of ⅜-in. round iron, threaded on one end. The assembled magnet shell is now placed in the lathe and the end of the core faced off true with the edge of the pipe. If desired, the whole magnet shell may be turned from one solid piece of wrought iron. Cast iron may be used, but in this case, the magnet will not be as powerful. Cast steel is the best material of all.

A fiber terminal strip, as shown in the detail, is made and fastened to the top plate with a machine screw. The binding screws should be countersunk into the strip so that they will not touch the top plate.

About 1 lb. of No. 18 double cotton-covered wire will be required. This may be wound on a wooden form and afterwards wrapped with tape or on a copper or brass form made as shown. A tin or sheet-iron form cannot be used. If the metal form is used, the completely wound form is slipped in place over the core. The ends of the coil are brought through the holes drilled on each side of the terminal strip. These holes must be insulated with fiber tubing.



The parts used in the magnet marked No. 2

A brass or copper retaining plate with a hole cut out for the core is pressed into the magnet shell to hold the coil in place.

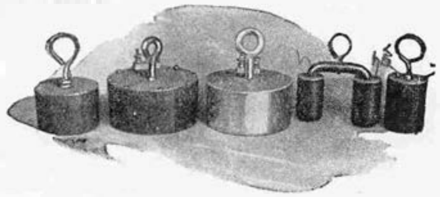
To obtain the greatest efficiency from the magnet, an armature plate should be made as shown. Its surface should be perfectly smooth and true so that it will make good contact with the magnet.

If the magnet shell were made of cast steel, it would support a weight of 500 lb., since the magnetic qualities of cast steel are greater than those of wrought iron. Cast iron is the poorest.

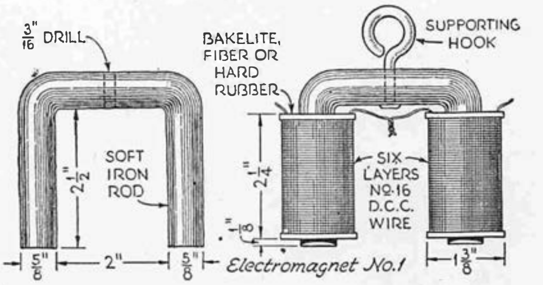
The magnet marked No. 1 is easier to make, but somewhat less efficient. When connected with two dry cells, it will support 50 lb. on a current consumption of 4 amperes.

Bend a piece of ⅝-in. soft iron rod, 7 in. long, to the shape shown, and drill a hole for the supporting hook. It is advisable to heat the iron before bending. If ⅝-in. iron is not available, a slightly larger or smaller size may be substituted if the holes in the end washers are changed accordingly.

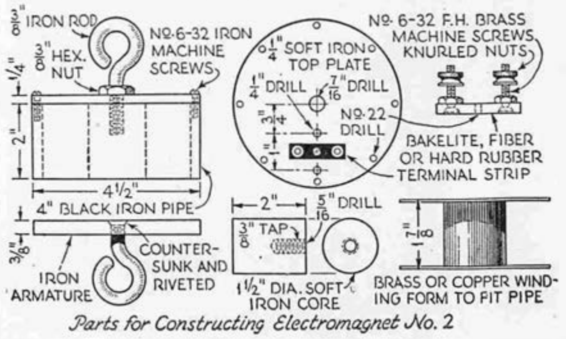
Place four insulating washers on the iron core, and wind six layers of No. 16 double cotton-covered wire on each leg. Wind each coil in the same direction and connect the inside wires. An alternate method of winding would be to wind each coil in the opposite direction and connect an inside and an outside wire, but the former provides a neater connection. The wires should be brought through the small holes drilled in the insulating washers. Flexible leads connected to the ends of the coils will greatly facilitate the use of the magnet and lessen the possibility of the leads breaking off where they come through the washers.



A variety of small, powerful electromagnets



Electromagnet No.1



Parts for Constructing Electromagnet No. 2

BRASSY FLASH-LIGHT REFLECTOR REFINISHED WITH ENAMEL

WHEN a flash-light reflector becomes worn and brassy, it can be improved by enameling it a glossy white. Carborundum paper should first be used to clean the metal; then apply a coat of shellac and rub lightly again. Finish with one coat of flat white paint and one of white enamel.

FIXING LOOSE WOOD SCREWS

WOOD screws can be made to hold in enlarged holes by forcing a stiff mixture of hardwood filings and shellac into the holes. If provision must be made for removing the screws at intervals, they may be dipped in melted petroleum jelly and then dried on the stove or in a hot oven. A screw so treated will hold well, but it may readily be backed.

Working Aluminum

FOR PANELS AND CABINETS

WITH the popularity of aluminum panels and chassis, metal working has become a common radio workshop operation. Metal cutting, bending, and drilling are now as important as soldering to the amateur who mounts his home-built sets in the modern manner.

While chassis and panels, as well as cabinets, can be bought made-to-measure, the radio worker can save time and money by buying the metal in large sheets and cutting and bending it to suit himself. It is easily worked and requires only the simplest tools. Besides, there is a certain satisfaction in making even a small home-cut panel.

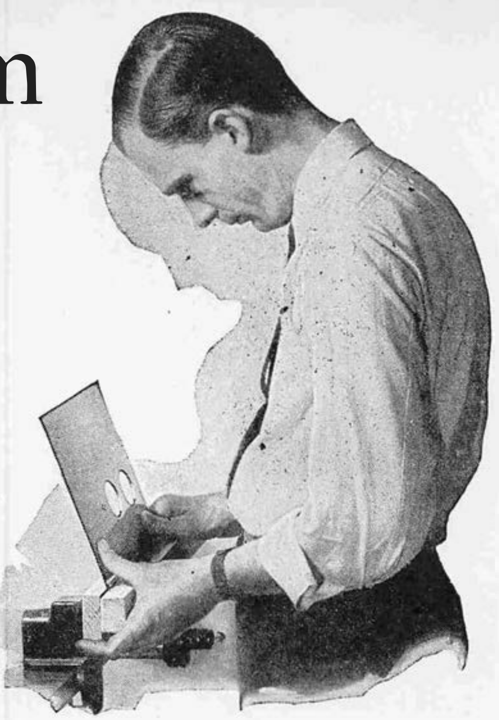
No difficulty should be encountered in cutting sheet aluminum. There are a number of simple methods that can be used. If the radio worker has a home workshop equipped with a motor-driven jig saw, he can save time by using it to cut his aluminum. All that is necessary is to substitute a metal-cutting saw for the usual wood saw. Feed the metal slowly, guiding the sheet so the blade follows a cutting line previously scribed with an awl or a sharp nail mounted in a wooden handle. Although its progress will be slower, an ordinary hand jig saw can be used in the same way.

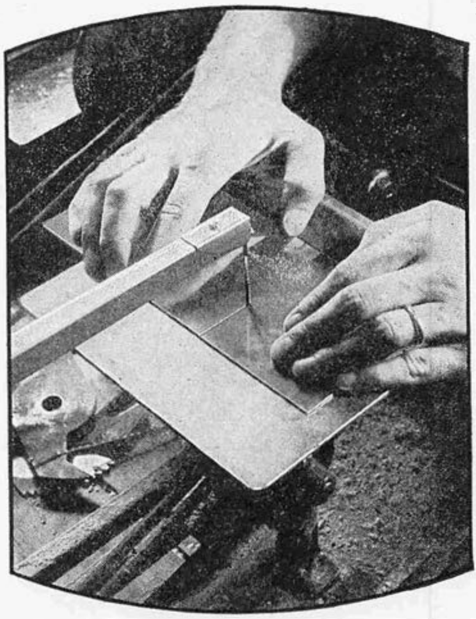
Where no jig saw is available, the aluminum can be cut by breaking it. Scribe a line on both sides of the metal where the break is desired and then go over the mark several times with a sharp knife. By cutting first on one side and then on the other, you can form two deep grooves. Finally, bend it back and forth over the sharp, square corner on the edge of the bench and it will break along the line of the cuts.

If rough edges result, place the sheet between two soft-wood boards, so that only about an eighth of an inch projects, and clamp it firmly between the jaws of a vise. A few cuts with a mill file will true off the edges.

In making a U-shaped aluminum chassis similar to that shown in the drawings, the amateur will do well to follow certain general rules of procedure. Once the sheet has been cut to the desired rectangle, the first step is to locate the bends and the centers for the various holes. By making a scale drawing of the chassis arrangement, confusion can be eliminated and mistakes avoided. Remember, aluminum marks up easily and any guide lines scribed on its surface are there to stay.

A good way to avoid waste of material is to build a chassis from cardboard first and check the location of parts. Then use the cardboard as a template for scribing.


Aluminum is so soft that, when clamped in a vise, it can easily be bent to desired shape by hand


With a jig saw, the amateur has no trouble in cutting sheet aluminum to any desired shape

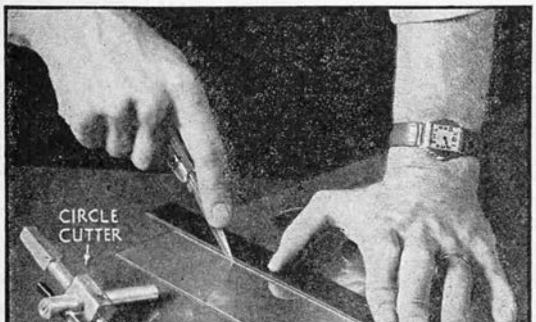
The second step in chassis making is drilling. The number of holes required will depend, of course, on the number of tube sockets and other parts that are to be mounted on the chassis. Each wafer-type tube socket will require one large hole (at least one and one quarter inches in diameter) and two smaller holes for the mounting screws. In planning these holes, it will be safest to take the measurements directly from the particular socket you are using.

Although small holes can be drilled with ordinary twist drills, the larger holes for the tube sockets present a different problem. One of the simplest solutions is to use the inexpensive circle cutter shown in the photographs. Being adjustable, it can be used to cut holes of various sizes and its sturdy tool-steel cutter can be used almost indefinitely without regrinding. Bits of this type can be obtained to fit either an ordinary hand brace or a motor-driven drill press.

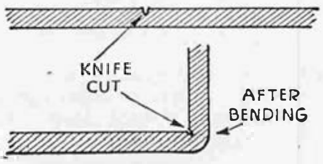
Because it is soft, aluminum tends to buckle and pull when being drilled. Also, it will clog the drill. To remedy this, feed the cutter slowly by applying an even pressure and lubricate the tool with light machine oil. If no machine oil is handy, smear a little soldering paste on the cutting point. This applies to regular drills as well as circle cutters. Mill or rat-tail files, which also will tend to clog when used on aluminum, can be lubricated by dipping them in turpentine.

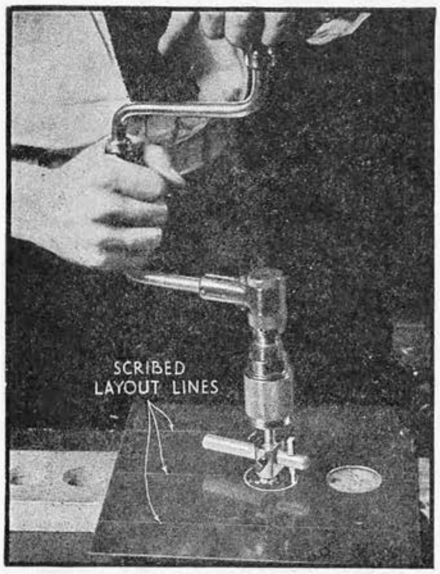
While the commercial circle-cutting tools offer the best and quickest means of cutting large holes, the amateur can use any one of a number of other improvised methods. For instance, such holes can be cut with a jig saw if the work is fed carefully. Simply drill a small hole to admit the blade and proceed with the cutting.

Even an old pair of sturdy dividers can be used to cut holes in thin aluminum. Grind the point of one leg at an angle to form a sharp edge. The remaining leg should be left pointed to serve as a center. To use the circle-cutting divider, make a center-punch mark at the center of the circle, set the dividers to the required radius and place the pointed leg in the center hole. By applying pressure, and scribing around and around, a deep groove will be cut. Then reverse the sheet and cut the other side. Finally, the sheet will be cut through to the point where the disk of waste metal can be pushed out with



Sheet aluminum can be scored with a sharp knife for bending as is shown at right. Circle cutter is also shown





Large holes, such as those for sockets, can be drilled in sheet aluminum with the inexpensive bit shown above. It can be adjusted

the thumbs, leaving a clean-cut opening.

All holes drilled in aluminum have a tendency to be ragged and rough. However, any burr that may form can be removed easily with the blade of a sharp knife or a rat-tail file.

By placing ordinary white enamelled shoe eyelets in small holes drilled to receive connecting wires, you can give your chassis a professional touch and also protect the wires against chafing. Insert the eyelet through the hole, rest the work on a soft board, and rivet over the split end of the eyelet by hitting a punch made from a drill rod a sharp blow with hammer. If drill rod is not handy, a centerpunch or a nail set can be used.

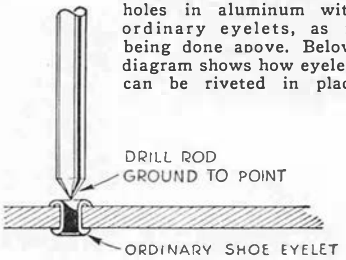
The third step in chassis making is bending. Although a special bending jig will save time, the amateur with limited equipment can do this portion of the work with a knife, a steel straightedge, an ordinary bench vise, and two hard-wood boards. First, a shallow groove should be scored with a knife on the back face of the material. This groove will prevent the metal from buckling. Then the sheet should be clamped in the vise between the two boards in such a way that the upper edges of the boards coincide with the groove. The actual bending can be done with the hands by merely pushing the metal slowly until a right angle is formed. To get a smooth corner, place a piece of soft wood over the corner while the metal is still gripped in the vise and pound it lightly with a mallet. Flanges on brackets and subpanels can be formed in this way.

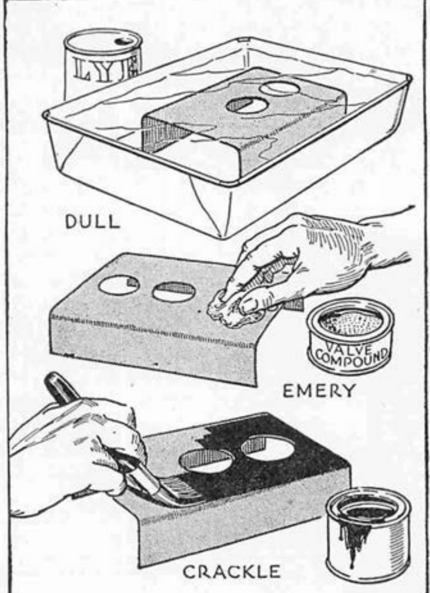
In FINISHING an aluminum chassis, panel, or cabinet, the amateur has a choice of three methods. The simplest perhaps is a dull mat finish obtainable by treating the metal with lye. In this process, the metal is simply immersed in a solution made by dissolving a can of ordinary household lye in a gallon of water. The resulting finish is soft and silvery.

A brighter, almost crystalline, finish can be obtained by rubbing the panel with emery cloth, starting with a rough variety and working up gradually to the finest grade. Many amateurs obtain this type of finish by using valve-grinding compound in place of the emery. It is inexpensive, handy, and can be easily applied.

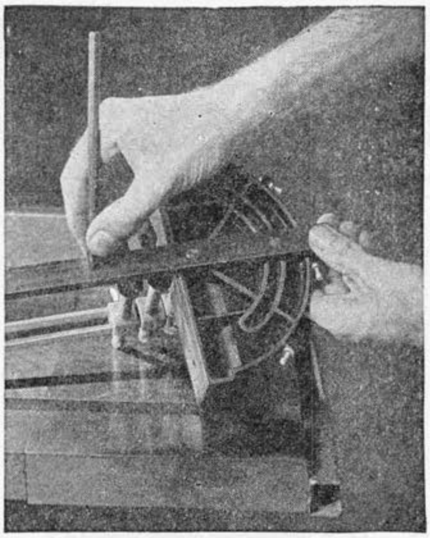
In the past year, a colored crystal or crackle type of finish has become popular on commercial receivers and transmitters. It is the same variety of finish used on cameras. The radio worker can imitate this commercial crystal effect in his home workshop by obtaining any one of a number of prepared crackle finishes. Sold in a variety of colors, they are merely brushed on the surface and drying does the rest. When finishing aluminum by this method, however, it is best to apply a ground coat of plain enamel of the same color before applying the crackle finish if you want a really good job.

Wires through chassis can be protected by fitting the holes in aluminum with ordinary eyelets, as is being done above. Below, diagram shows how eyelets can be riveted in place





The drawings above illustrate various methods of applying an attractive finish to the aluminum parts of your radio receiver



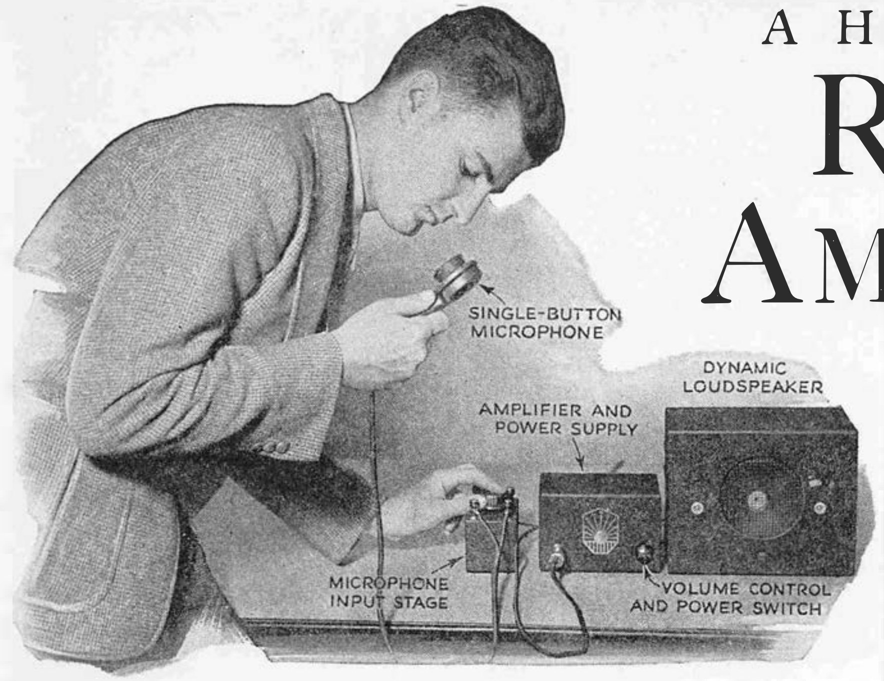
Graphite and beeswax, when molded in pencil form, form a fine lubricant for such parts as the miter-gage channels of a circular saw. *Below:* Melting out the "pencil"

GREASELESS LUBRICANT USED LIKE PENCIL

You will find many uses around the home, shop, and garage for a lubricating pencil made of finely powdered graphite and beeswax. A thin coating of the graphite-carrying wax rubbed on the latches of automobile doors will make them work smoothly, yet will not come off on clothing. For lubricating the miter-gage channels in circular saw tables, for waxing nails so that they can be driven more easily, and for hundreds of other jobs, the pencil will be found valuable.

Obtain some beeswax and about an equal volume of very fine (impalpable) graphite. Melt the wax in an old can and stir in the graphite. Pour the wax into a metal tube of from 3/8 to 1/2 in. inside diameter, the lower end of which should be plugged. After the mixture has solidified, heat the tube gently with a torch or gas flame until the wax pencil slides out, but first remove the plug in the lower end of the tube to prevent suction. A layer or two of paper glued around the pencil makes it easier to hold. The graphite is the lubricating medium. The purpose of the wax is nothing more than to serve as a carrier.

A HIGH-POWER RADIO AMPLIFIER



The amplifier in use for public-address work. It provides a power output of almost three watts

BECAUSE it can be used as a public-address system, as a phonograph pick-up, or with a small receiver, this "mighty dwarf" amplifier forms an ideal three-in-one unit for the radio experimenter. Although it is small enough to fit into the palm of your hand, weighs only two pounds, and costs little to build, it provides an undistorted power output of almost three watts.

Employing three metal tubes, the circuit consists of two stages of audio amplification, a self-contained power supply, and a rectified 110-volt field supply for a dynamic speaker. The first-stage amplifying tube, a metal type 6J7, is resistance-coupled to the power-output stage, employing a 25A6 metal tube.

Instead of using a power transformer to furnish the high plate voltage, a type 25Z6 metal tube is wired in a voltage-doubler circuit to provide the necessary 180 volts. The filtering system consists of the speaker field shunted by two 8-mfd. tubular electrolytic condensers.

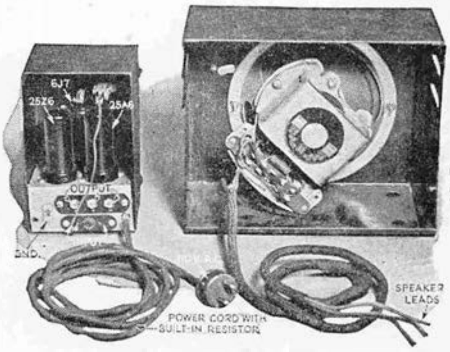
As indicated in the schematic diagram, the filaments of the three tubes are connected in series, a 200-ohm resistor built into the power cord reducing the line voltage to the correct value required by the tubes. Although the general arrangement resembles a universal A.C.-D.C. circuit, this amplifier, due to the voltage-doubler connection of the 25Z6 tube, can be used only on alternating current. To reduce the possibility of shocks, the common negative return is insulated from the metal chassis by a .1-mfd. cartridge-type condenser.

In wiring the amplifier, the chief danger of making a mistake lies at the socket terminals. To eliminate the possibility of any trouble at these points, the tube elements on the schematic diagram are lettered and corresponding lettering is used to designate the terminals in the three socket views.

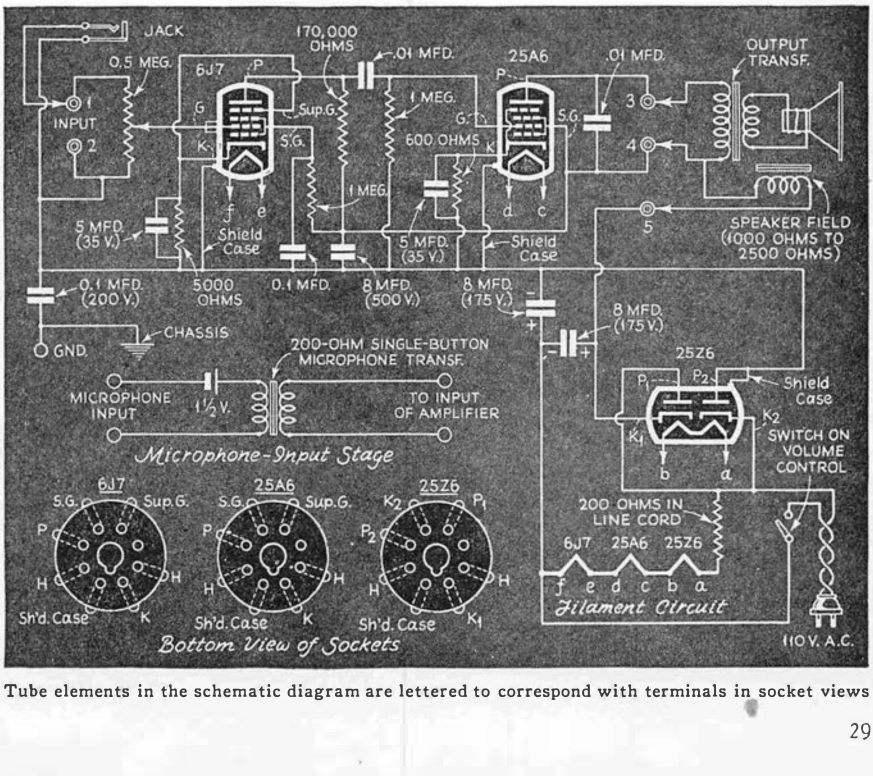
The complete amplifier circuit is mounted on a metal chassis, the three tube sockets being mounted on the chassis deck; the resistors and condensers under the chassis; the input, output, and ground terminals at the rear; and the volume control and input jack on the front wall. The two pin jacks at the rear of the chassis serve as the standard input connections to the amplifier for phonograph pick-up and receiver work, while the three output binding posts are for making connections to the output transformer and field of the dynamic speaker. The plug jack at the front of the chassis simplifies the problem of plugging in a microphone or other additional circuits.

A simple microphone-input stage is a necessary complement to the amplifier if it is to be used as a public-address system. Since the input stage consists simply of a small 200-ohm, single-button microphone transformer, a one and one-half-volt flash-light battery, and provisions for making connections to the microphone and the input of the amplifier, the entire device may be mounted in an extremely small metal box, similar to the one illustrated. Although a variable resistance was used as a part of the original input stage shown, it can be omitted, since adequate control is provided by the 500,000-ohm potentiometer used in the main amplifier circuit.

The dynamic speaker can be mounted in a separate cabinet, made either of metal or wood. If a metal cabinet is used as in the original, a wall-board or wood baffle should be provided. The speaker should be equipped with an output transformer to match a type '43 or a 25A6 tube. These tubes have a load resistance of about 5,000 ohms. The speaker field may have a resistance of from 1,000 to 2,500 ohms. A three-wire cable is sufficient to make the connections from the speaker to the amplifier.

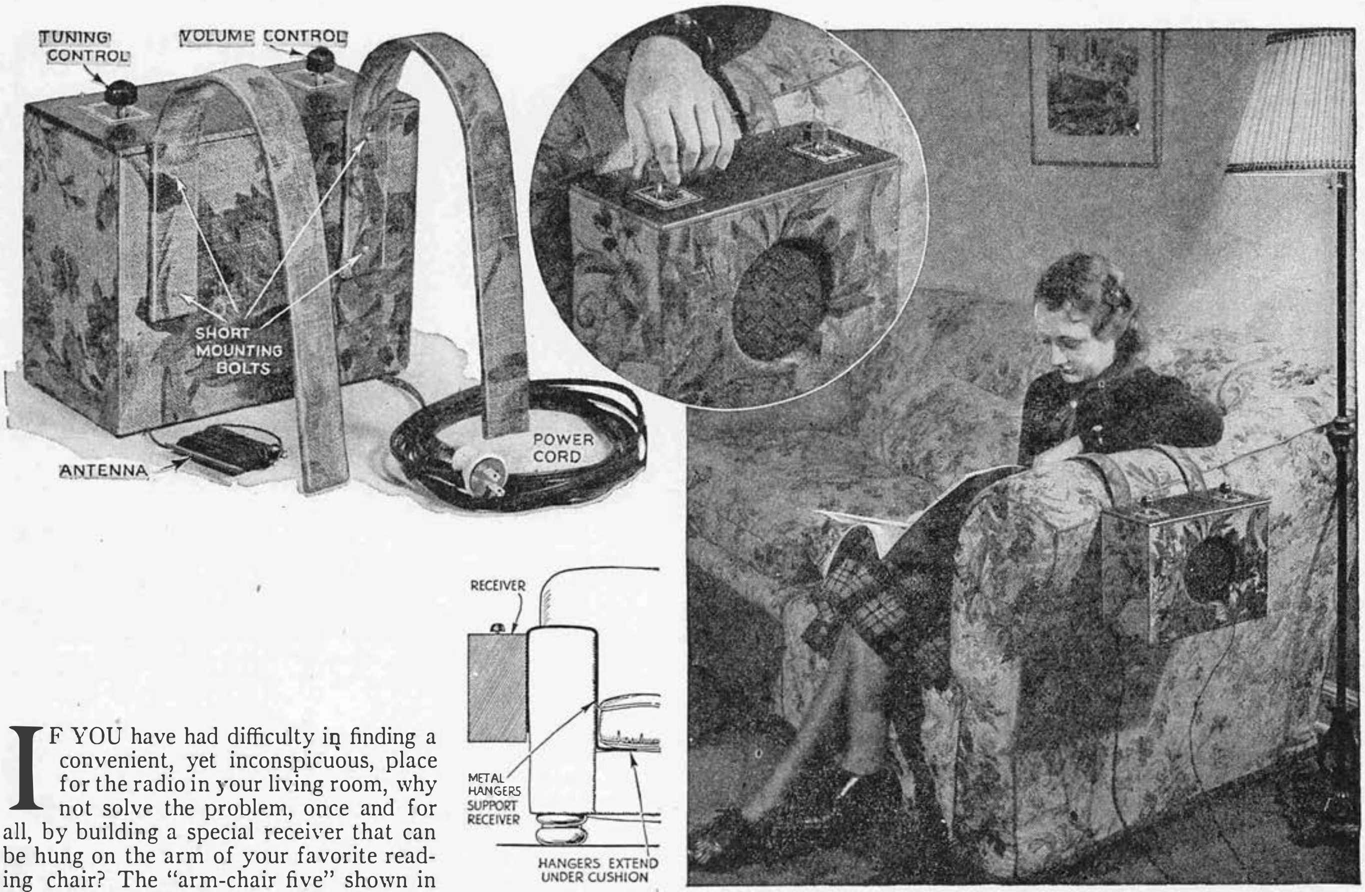


Rear view of the amplifier and loudspeaker units. Note the small size of the amplifier



Tube elements in the schematic diagram are lettered to correspond with terminals in socket views

Arm-Chair Radio Set



The "arm-chair five" in use. Housed in a cabinet that is covered with tapestry to match the upholstery, it hooks over the arm of a favorite chair or sofa. Specially designed for the purpose, the receiver has its tuning controls placed conveniently on the top, and is both light and compact

IF YOU have had difficulty in finding a convenient, yet inconspicuous, place for the radio in your living room, why not solve the problem, once and for all, by building a special receiver that can be hung on the arm of your favorite reading chair? The "arm-chair five" shown in the accompanying photographs will enable you to spend a quiet evening reading in your favorite easy chair, and at the same time, have everything the radio programs offer right at your finger tips.

The circuit, as a glance at the diagram will show, is a straightforward, tuned-radio-frequency hook-up powered by an A.C.-D.C. power supply. Using four of the newest all-metal tubes, it employs a 6K7 as a radio-frequency amplifier, a 6J7 as a biased detector, a 25A6 as the power amplifier, and a 25Z6 as the rectifier. A fifth tube, a glass unit (185R), is a new plug-in resistor which supplies the necessary filament resistance to reduce the 110-volt house current to the required value. The use of this tube eliminates the usual bulky built-in resistor power cord found on most A.C.-D.C. receivers.

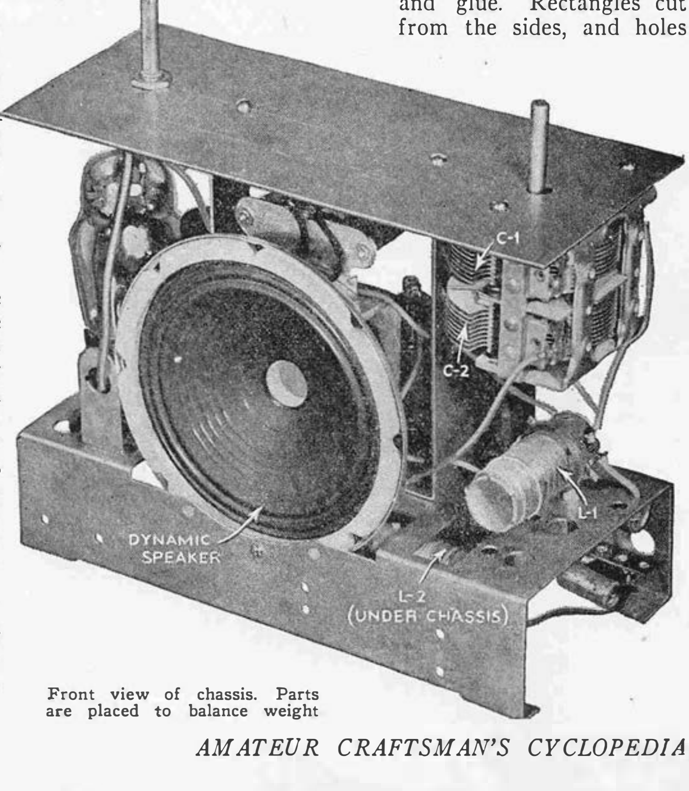
In building the aluminum chassis, use an ordinary commercial two by four by nine-inch A.C.-D.C. chassis, drilled to take five sockets, as the base. On this, construct a superstructure consisting of a four by nine-inch aluminum panel supported on two five-inch-high, S-shaped aluminum brackets. The panel serves as a mounting surface and support for the two tuning controls—the two-gang variable condenser (C_1 and C_2) and the volume control (R_1). To obtain the necessary rigidity, sheet aluminum at least one sixteenth inch thick should be used.

The five wafer-type tube sockets, one tuning coil (L_1), and the five-inch dynamic speaker are mounted on top of the chassis base, while the fixed condensers, resistors, and second tuning coil are placed under the chassis. By arranging the parts symmetrically, as shown, the weight will be evenly distributed and provide good balance.

To give best results, the two matched tuning coils (L_1 and L_2) should be Litz-wound. These can be obtained from almost any dealer in radio parts and should be bought as a pair or set. They can be mounted easily on the chassis with long bolts passed through short sections of dowel rod to provide insulation.

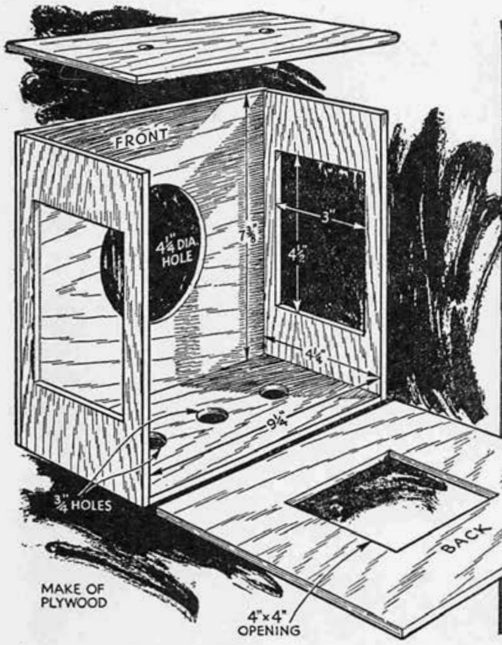
Little difficulty should be experienced in wiring the parts, provided the circuit diagram is followed closely. Pay particular attention to the wiring of the power-supply filter circuit. To save parts and cut down on the cost, the field coil of the dynamic speaker is wired into the circuit as a filter choke, while a two-watt, 5,000-ohm resistor (R6) serves in place of the second filter choke.

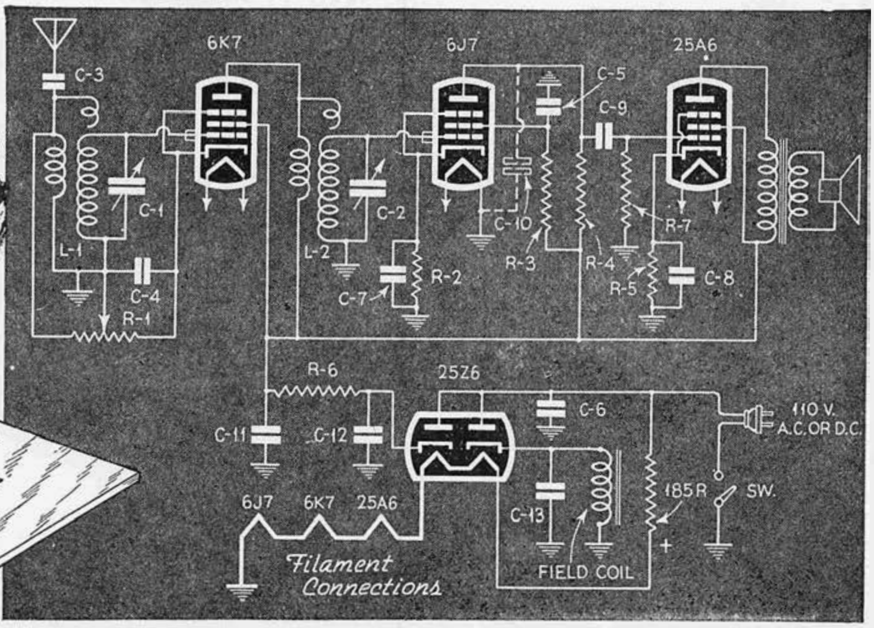
Consisting of a wood box covered with upholstery material, the cabinet must be constructed to give good ventilation to prevent overheating of the tubes. As shown in the drawings, it is made of plywood and assembled with screws, nails, and glue. Rectangles cut from the sides, and holes



Front view of chassis. Parts are placed to balance weight

Made of Standard Parts





The circuit is a straightforward, tuned-radio-frequency hook-up, powered by an A.C.-D.C. power supply. It uses four new-type, all-metal tubes, and a glass unit as a resistor. The drawing at the left gives construction details for the light, wooden, tapestry-covered cabinet that houses the set

drilled in the bottom, provide a good circulation of air, while a hole cut in the back behind the speaker eliminates any possibility of bothersome rumbles and rattles.

To provide a cover for the aluminum panel, an attractive top for the cabinet can be fashioned from a piece of mahogany, maple, or pine. This can be fastened in place with four screws.

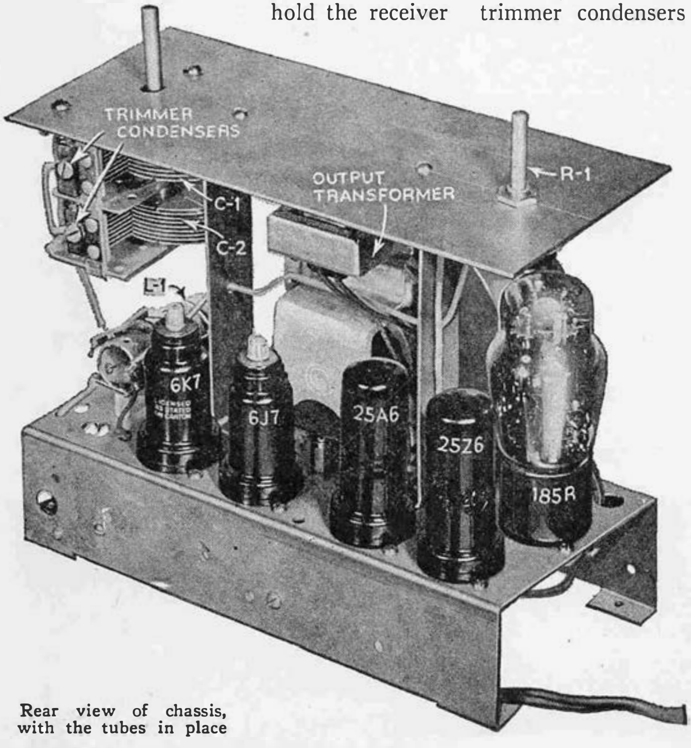
When buying the covering material for the cabinet, select a cloth that is loosely woven. With a little shopping around, it will not be difficult to find just the right color, texture, and weight to match your upholstery. The cloth is applied to the cabinet with glue.

In constructing the upholstery-covered arm hooks that hold the receiver in place on the chair, particular attention must be paid to their length. To provide a substantial support, they should be long enough to extend over the arm and down under the side of the end cushion, as indicated in the illustrations. The weight of the cushion will help hold the receiver firmly in place. Although ordinary sheet aluminum can be used for the hooks, carefully formed strips of spring steel will be stronger and grip the arm of the chair. The hooks are fastened to the back of the receiver with short bolts that extend through the rear face of the cabinet.

When the wiring has been carefully checked, the set should be tested and the trimmer condensers adjusted before the chassis is slipped into the cabinet. This is done by tuning the receiver to the strongest local broadcasting station and turning the adjusting screws on the trimmers first one way and then the other to obtain maximum volume. Repeat the operation on several stations, to insure the best possible balance for all conditions.

If desired, the tone of the set can be altered, within bounds, by placing a fixed condenser between the plate of the detector tube and the chassis, as shown by the dotted line in the circuit diagram. The condenser should have a value between .0002 and .0005 mfd. Which capacity will operate best can be found only by experiment. Incidentally, the use of this condenser will not only change the tone of the receiver but also will do a great deal toward eliminating bothersome man-made static.

For general operation, an ordinary twenty-five foot A.C.-D.C. antenna will give good results. Although an outside antenna can be used, if desired, under no conditions use a ground. Any connection between chassis and ground will result in blown-out tubes.



Rear view of chassis, with the tubes in place

LIST OF PARTS

C_1 and C_2.—Variable condensers, .00036 mfd., ganged.

C_3.—Fixed condenser, tubular, .01 mfd.

C_4, C_5 and C_6.—Fixed condensers, tubular, 1 mfd.

C_7 and C_8.—Electrolytic condensers, 5 mfd.

C_9—Fixed condenser, tubular, .02 mfd.

C_{10}.—Fixed condenser, mica, .0002 mfd., optional.

C_{11} and C_{12}.—Electrolytic condensers, 8 mfd.

C_{13}.—Electrolytic condenser, 16 mfd.

R_1.—Volume control, 10,000 ohm, with switch.

R_2.—Fixed resistor, 30,000 ohm, ½ watt.

R_3.—Fixed resistor, 2 megohm, ½ watt.

R_4.—Fixed resistor, 400,000 ohm, ½ watt.

R_5.—Fixed resistor, 600 ohm, 1 watt.

R_6.—Fixed resistor, 5,000 ohm, 2 watt.

R_7.—Fixed resistor, 1 megohm, ½ watt.

L_1 and L_2.—Commercial tuning coils, matched, Litz wound.

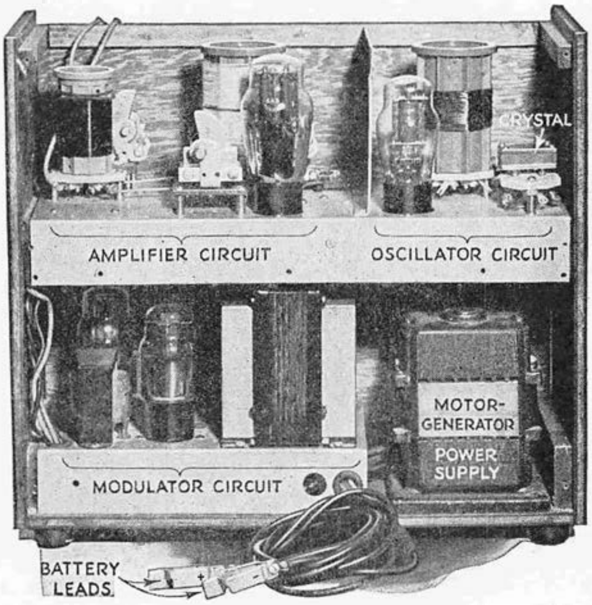
Miscellaneous. — Dynamic loudspeaker, metal chassis, upholstery-covered cabinet, four octal midget sockets, one four-prong midget socket, tubes (6K7, 6J7, 25A6, 25Z6, and 185R), antenna wire, knobs, power cord, screws, lugs, solder, etc.

A Portable

BUILT TO

A Miniature Motor-Generator Set Provides a 300-Volt Power Supply For This Light, Versatile Outfit

The portable transmitter in use. The radio-frequency unit is mounted on a separate chassis and can be used independently as a c.w. transmitter for code work



Rear view of the outfit, showing the locations of the various units. Each portion of the circuit can be removed separately

DESIGNED to operate on a single six-volt storage battery, the short-wave transmitter illustrated is an ideal unit for the radio amateur who wants a powerful yet portable circuit. Covering the wave lengths from twenty to 160 meters on either code or phone, the compact outfit is capable of an undistorted output of more than twenty watts.

In most battery-operated transmitters, the low voltage available makes it impossible to obtain any great amount of output power. Through the use of a miniature motor-generator set, however, this circuit is provided with a 300-volt, 150 milliampere power supply. The lightweight power unit, operating on an ordinary six-volt storage battery and supplying direct current, eliminates the necessity of expensive "B" batteries and complicated filter networks.

To provide maximum flexibility, the transmitter is constructed in three separate parts. The top section contains the radio-frequency, crystal-controlled oscillator, the class "C" amplifier, and the antenna-coupling unit. The bottom section houses the modulator and the midget motor-generator power supply. Each section can be easily removed and, despite the compactness of the entire circuit, there is no troublesome crowding of either the parts or the wiring.

In the interest of simplicity, the circuit has been designed along strictly conventional lines. The oscillator, a type '42 tube, is capacitively coupled to the class "C" amplifier through a small mica compression-type condenser. This together with the 6A3 output tube is mounted as a unit on a single chassis.

For maximum transfer of power to the antenna, the output tank circuit is link-coupled to the antenna coil. One or two turns of wire wrapped around the amplifier tank and two or three turns around the antenna coil were found to provide good output to the antenna on all bands. A little experimenting with the link coupling, however, is advised, since tight coupling may cause poor modulation when the circuit is used for phone.

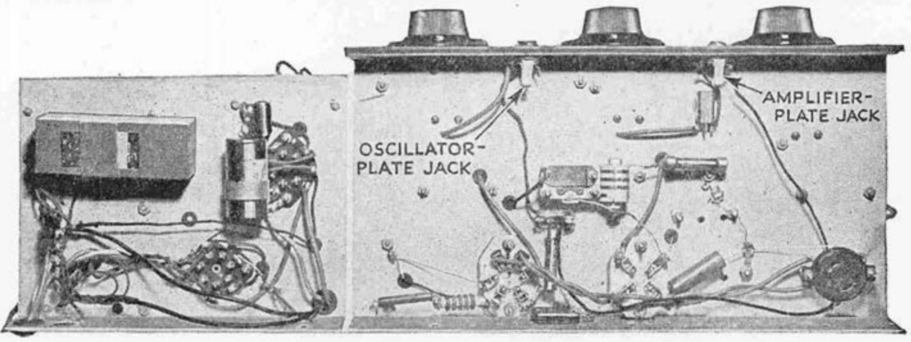
To obtain maximum output from the radio-frequency portion of the transmitter, it is essential that all parts be of low-loss construction and that the tuning condensers be thoroughly insulated from the aluminum chassis. The sockets for the tubes and plug-in coils should be made of isolantite or similar material. It should be remembered, that, owing to the capacity effect of the dielectric, a good insulator for direct current is not necessarily a good insulator for radio frequencies.

Because it is mounted on a separate chassis, as an individual unit, this portion of the circuit can be used independently as a c.w. transmitter for code work, if desired. The modulator unit can be added later and the combined circuits then used as a combination code and phone transmitter.

The modulator, mounted on a separate chassis fitted into the lower shelf, uses two 6A6 tubes. There are no tricks to this circuit, since it is basically a straight audio amplifier.

To insure good quality, a heavy-duty output transformer is recommended. The unit used in the original is capable of carrying the full current of the class "C" stage without difficulty. If a smaller transformer is used, it will be necessary to keep the direct current for the modulated amplifier out of the secondary windings through the use of an extra audio choke and condenser. The choke should have an actual inductance of thirty or more henries with a current rating of 100 milliamperes. The condenser should have a capacity of about four microfarads and be rated at 600 volts.

Since the "gain" of the speech system is just about right for the average single-button microphone powered by a 4½-volt battery, no "gain control" is incorporated. The "gain," however, can be varied by the simple expedient of moving the microphone closer to, or farther away from, the speaker. A distance of about six inches will be found to be correct for most single-



Bottom views of the radio-frequency and modulator chassis. Note their independent construction

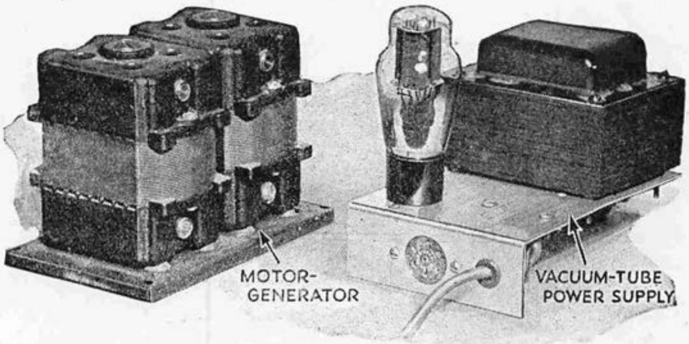
Short-Wave Transmitter

OPERATE ON SIX-VOLT BATTERY

COIL-WINDING DATA

Coil	1750 KC.	3500 KC.	7000 KC.	14,000 KC.
L^1	50 turns No. 22. E. 2" form	34 turns No. 22 E. 1½" form	19 turns No. 16 E. 1½" form	9 turns No. 14 E. 1½" form
L^2	54 turns No. 18 E. 2" form	38 turns No. 18 E. 1½" form	21 turns No. 16 E. 1½" form	11 turns No. 14 E. 1½" form
L^3	45 turns No. 18 E. 1½" form	28 turns No. 18 E. 1½" form	15 turns No. 16 E. 1½" form	7 turns No. 16 E. 1½" form

If the circuit will not tune to resonance, a few turns must be added or removed from the above coil data. However, the above data is correct for use with the tuning condensers specified in the list of parts.



The two power supplies that enable the set to operate on either house current or a small battery

button microphones under normal voice conditions.

Originally developed for airplane service, the lightweight motor-generator set used as the power supply is ideal for use in a portable transmitter. The motor, driven by a storage battery, is quick-starting and the generator builds up to its full voltage of 300 volts almost instantaneously. In wiring the power supply, it is important that heavy leads be used between the motor-generator and the storage battery as any drop in the input voltage will seriously affect the output. Two No. 8 insulated wires provided with terminal clips were used in the original.

For those who do not desire the motor-generator power supply, a standard vacuum-tube power circuit can be substituted. Such a circuit, mounted on a chassis, is shown in the photographs. An outside source of 110-volt alternating current is necessary if the tube circuit is used.

The antenna arrangement employed will depend to a large extent upon space limitations. For the 160-meter band, the regular Marconi antenna-ground system will prove to be quite efficient and the easiest of all types to set up. The length is not critical, as there is considerable latitude due to the size of the tuning condenser used in the antenna circuit. For the other amateur bands, the ¼-wave Hertz is recommended.

The transmitter can be tuned in any of the conventional ways with either meters, a neon glow lamp, or a small radio dial bulb arrangement can be used. If the dial bulb is used, connect a two-inch loop of wire to the terminals of the lamp. No loop is needed when the neon lamp is used.

Although no meters are included in the transmitter, provision for measuring oscillator and class "C" amplifier plate current is made by means of closed-circuit jacks on the front panel. When neutralizing, the switch in the "B" plus lead of the 6A3 tube should be in the "off" position.

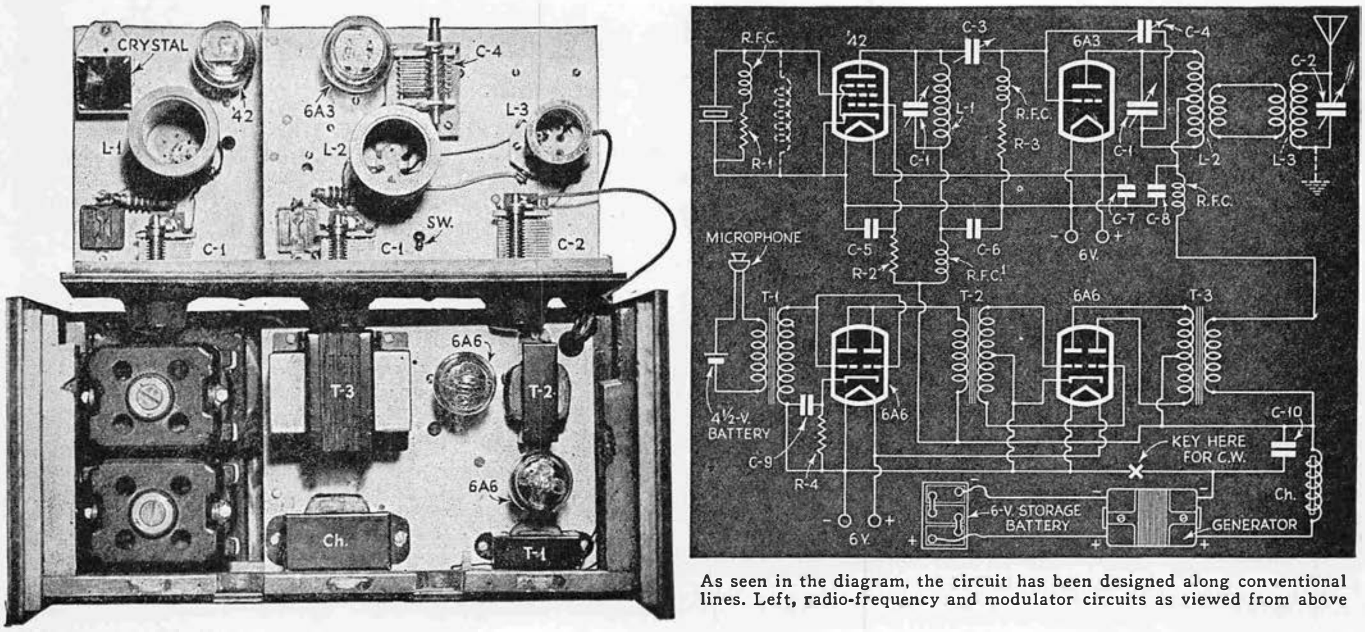
The distance-covering possibilities of the circuit will depend, to a large extent, on the radiation efficiency of the individual antenna system, the wave band used, the location of the station, and general atmospheric conditions.

As with all short-wave transmitters, this circuit should not, of course, be operated unless the owner is a licensed amateur. However, the lack of a license need not prevent you from building the circuit, and when your license is granted your station will be complete and ready to go.

LIST OF PARTS FOR THE SHORT-WAVE TRANSMITTER

C_1.—Variable condenser, 100 mfd.
C_2.—Variable condenser, 250 mfd.
C_3.—Variable condenser, 220 mfd.
C_4.—Variable condenser, 50 mfd.
C_5 and C_6.—Fixed condensers, mica, .01 mfd.
C_7.—Fixed condenser, paper, .05 mfd.
C_8.—Fixed condenser, mica, .001 mfd.
C_9.—Electrolytic condenser, 25 volt, 50 mfd.
C_{10}.—Electrolytic condenser, 450 volt, 16 mfd.
R_1.—Resistor, metallized, 25,000 ohm, 1 watt.
R_2 and R_3.—Resistors, metallized, 50,000 ohm, 2 watt.
R_4.—Resistor, metallized, 1,000 ohm, 2 watt.
T_1.—Transformer, single-button microphone.
T_2.—Transformer, class "B" input.
T_3.—Transformer, modulation.
Ch.—Choke, 90 ohm, 150 ma.
RFC—Radio-frequency choke, 2 mh.
RFC_1.—Radio-frequency choke, 8 mh.

Miscellaneous.—Motor-generator set (300-volt, 150 ma.), tubes, sockets, coils, microphone, key, chassis, cabinet, jacks, switches, dials, control crystal, wire, etc.

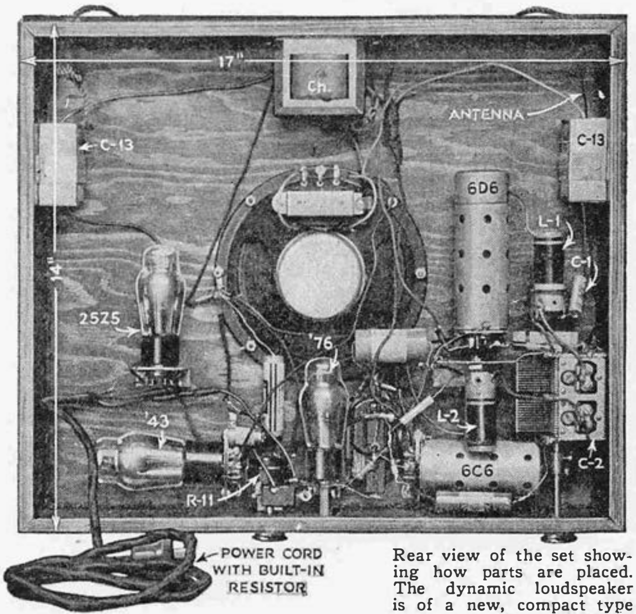


As seen in the diagram, the circuit has been designed along conventional lines. Left, radio-frequency and modulator circuits as viewed from above

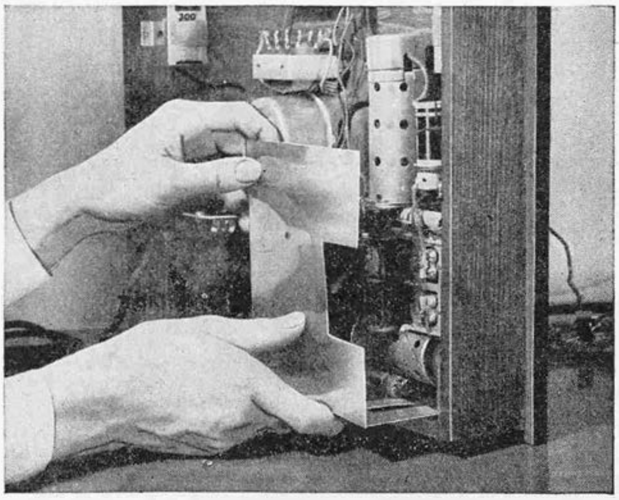
Make a Picture-

Efficient All-Electric, Five-Tube Broadcast Receiver Hides Behind a Framed Tapestry

Hung on the wall, this radio is out of the way yet always within easy reach



Rear view of the set showing how parts are placed. The dynamic loudspeaker is of a new, compact type that does not have a field coil



A sheet of aluminum shields the radio-frequency and detector stages

CLEVERLY disguised as an attractive picture, this novel homemade radio set can be hung on your wall. To all appearances, it is simply a framed piece of decorative tapestry supported by a gilt picture cord. Yet, its three-inch depth hides an efficient all-electric, five-tube broadcast receiver—loudspeaker and all.

Even the antenna lead-in is concealed. Running up through the braided-silk picture cord, it can be connected easily to an indoor antenna hidden behind the picture molding. The power cord also can be hidden by providing a wall outlet directly behind the frame. If this is impractical, the cord can be painted white or cream and partly concealed by running it down the corner of the room to an existing outlet in the baseboard.

Despite its compactness, however, the circuit is anything but crowded. As a matter of fact, a ten-tube set could easily be housed in the same space without difficulty. The parts are well spaced to simplify both the wiring and the placing of condensers, resistors, and tubes.

As indicated in the diagram, the circuit consists of a single tuned radio-frequency stage (6D6), a tuned detector (6C6), two resistance-coupled audio stages ('76 and '43), and a half-wave rectifier (25Z5). Since the circuit is designed to operate on either alternating or direct current, the familiar built-in-resistor power cord is used to supply the correct voltage to the filaments of the tubes. For a line voltage of from 105 to 120 volts, this resistance should have a value of 165 ohms; for 220 volts, a value of 570 ohms.

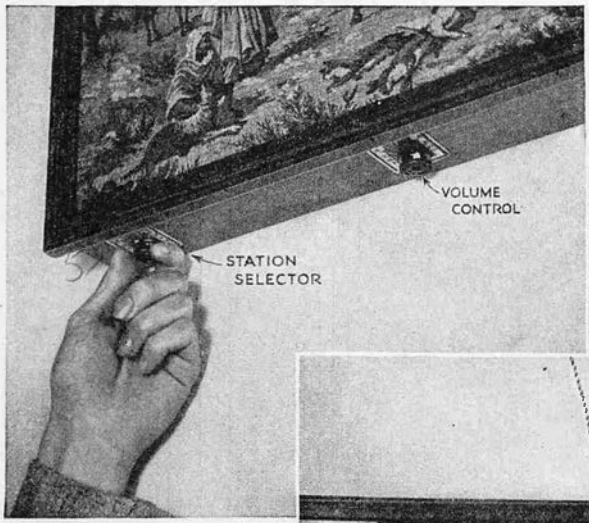
All parts used in the set are standard. The coils (L_1 and L_2) are ordinary high-gain units of the type used in commercial midget AC-DC receivers. They can be obtained from most large dealers in radio supplies. The main tuning condenser is a two-gang unit with a capacity of .00035 mfd. One section serves for the tuned radio-frequency stage, the other for the tuned detector.

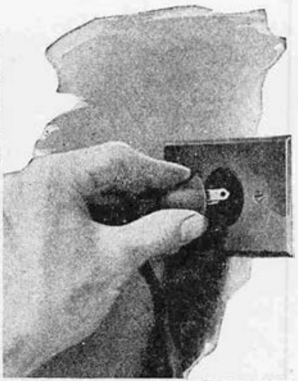
For simplicity, the number of tuning controls has been been kept to a minimum. They consist simply of the condenser dial and a volume control mounted on the bottom edge of the frame so that they are concealed from view yet readily accessible. The volume control, which also contains a built-in power switch, serves to vary the grid-bias resistance of the '43 tube and should be mounted near it to keep the leads short. Short leads also are important in the grid circuits of the radio-frequency and detector tubes.

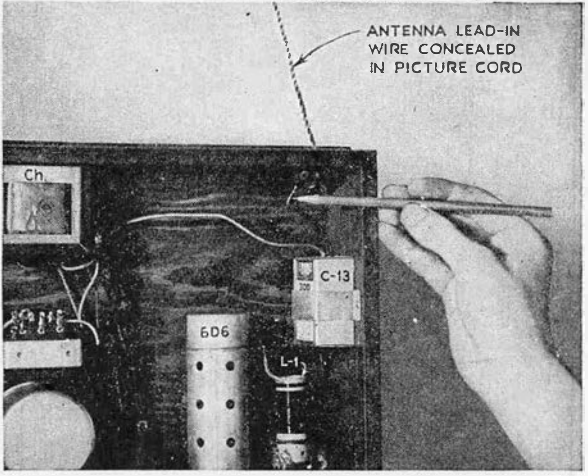
The filaments of the five tubes are wired in series with the built-in resistor. For best results and a minimum of hum, they should be connected in the exact order shown in the schematic diagram. Before making these connections, it is absolutely necessary to know which of the three wires in the power cord is the resistance. If you make the mistake of connecting the two copper wires so that they feed the full 110-volt potential of the house current into the filaments, you will find yourself with a blown-out tube. This information about the power cord should be obtained from your dealer when you make the purchase.

Although any type of efficient loudspeaker can be used, a new compact dynamic unit was used in the original. Operating without a bulky field coil, it takes up little space in depth and yet provides good volume and quality. Mounted in the picture frame, it is provided with a good wood baffle and, since it is aimed slightly downward by the tilt of the picture, it

Frame Radio TO HANG ON YOUR WALL







CONTROLS AND LEADS CLEVERLY HIDDEN

The two tuning controls (condenser dial and volume control) are mounted on the bottom edge of the frame, as shown above. Upper right, a wall outlet installed directly behind the picture makes it possible to conceal the power cord. Antenna lead is connected to a wire hidden in the picture cord, as at right

LIST OF PARTS

R_1.—Fixed resistor, metallized, 300 ohm, 1 watt.
R_2.—Fixed resistor, metallized, 50,000 ohm, ½ watt.
R_3.—Fixed resistor, metallized 30,000 ohm, ½ watt.
R_4.—Fixed resistor, metallized, 15,000 ohm, 1 watt.
R_5.—Fixed resistor, metallized, 2 megohm, ½ watt.
R_6.—Fixed resistor, metallized, 50,000 ohm, ½ watt.
R_7.—Fixed resistor, metallized, 100,000 ohm, ½ watt.
R_8.—Fixed resistor, metallized, 500,000 ohm, ½ watt.
R_9.—Fixed resistor, metallized, 2,000 ohm, 1 watt.
R_{10}.—Fixed resistor, metallized, 250,000 ohm, ½ watt.
R_{11}.—Variable resistor, with switch, 500,000 ohm.
R_{12}.—Fixed resistor, metallized, 600 ohm, 1 watt.
R_{13}.—Line cord resistor (see text).
C_1.—Fixed condenser, .001 mfd.
C_2.—Variable condenser, two gang, .00035 mfd.
C_3.—Fixed condenser, .05 mfd.
C_4, C_5, C_7.—Fixed condensers, .1 mfd.
C_6.—Fixed condenser, 5 mfd.
C_8.—Fixed condenser, .5 mfd.
C_9, C_{11}.—Fixed condensers, .005 mfd.
C_{10}, C_{12}.—Electrolytic condensers, 10 mfd.
C_{13}.—Fixed condenser, 16 mfd.
C_{14}.—Fixed condenser, .001 mfd.
Ch.—Choke, 30 henry.
R. F. C.—Radio-frequency choke, 8 mh.
Misc.—Speaker, tapestry, frame, wood for cabinet, sockets, tubes, coils, wire, etc.

provides better directional effects than those afforded by a loudspeaker mounted in the ordinary vertical cabinet.

As for the frame and shallow cabinet, the amateur can make his own or have one made to order at his neighborhood picture shop for a few dollars. It consists simply of a narrow mahogany frame mounted on a rectangular box. The front of the box, which serves as the baffle and mounting for the speaker as well as the backing for the tapestry picture, is a piece of plywood cut to fit inside the rectangular cabinet and rest against the inside edge of the frame. Holes drilled in the top edge of the cabinet take the ends of the picture cord and provide an outlet for the concealed antenna lead.

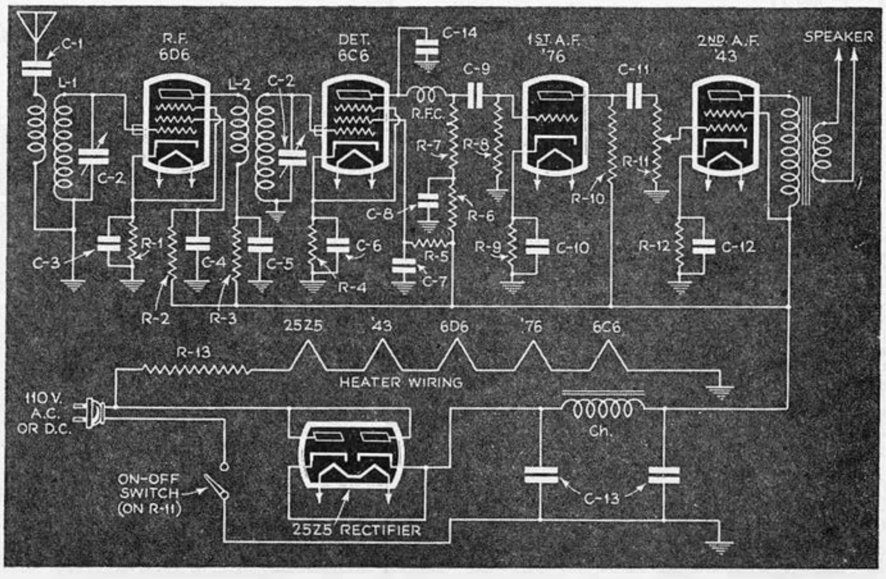
Incidentally, although a conventional V-shaped, gilt picture cord was used to hang the original receiver, two separate vertical cords could be used as well. If this is done, one cord could be used to conceal the antenna lead-in while the other could hide the insulated power-cord lead. The power cord then could be concealed in the picture molding and led to a convenient outlet. Of course, in this case a power cord with a built-in resistance would be far too bulky so that it would be necessary to install a separate voltage-dropping unit within the set.

If desired, regular silk-covered lamp cord can be used to hang the picture. The insulated wires then could serve as the power-cord lead and antenna lead. Decorative gilt tassels placed at the picture molding will cover the picture hooks and complete the disguise.

Due to the high gain of the radio-frequency and detector stages, adequate shielding is necessary. Although only a single shield placed over the tuned circuit was used in the original receiver, additional aluminum shields placed around each of the tubes (6D6 and 6C6) would improve the sensitivity by making it possible to eliminate the 30,000-ohm resistor (R_3).

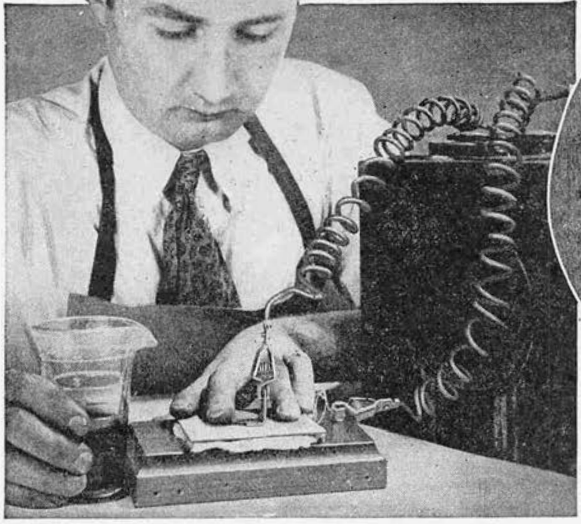
Since no external ground connection is used, one side of the power line serving as the ground, a blocking condenser (C_1) must be wired in series with the antenna lead to isolate it from the circuit. This condenser must not be omitted under any conditions.

The set tunes like any broadcast receiver, a decorative surface dial mounted under the knob control providing numbered divisions for station logging. For the sake of balance, a similar dial can be placed under the volume-control knob as shown in the illustrations.

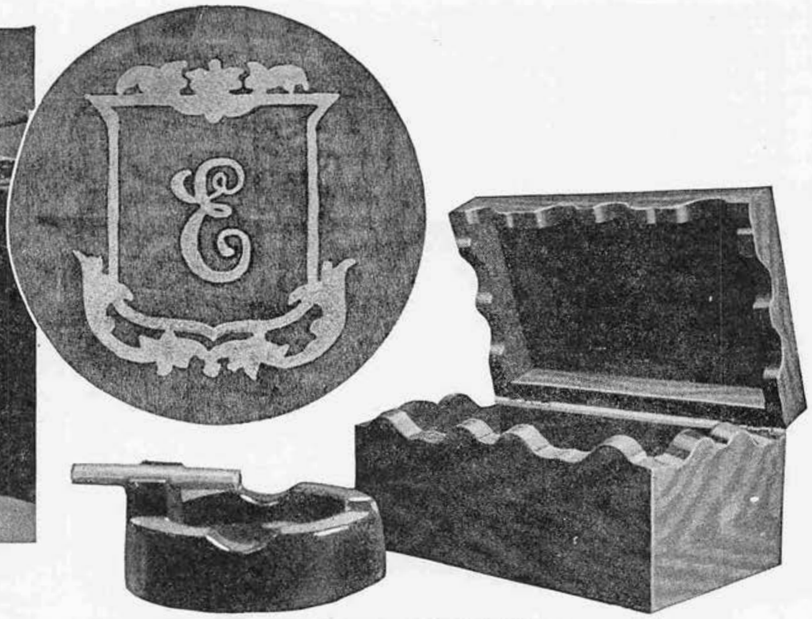


The circuit is of the simple tuned-radio-frequency type. The spacing of parts makes wiring easy

Plating Metal



Small designs can be plated by means of two or three ordinary dry cells, but when considerable metal must be deposited, it is better to use a storage battery



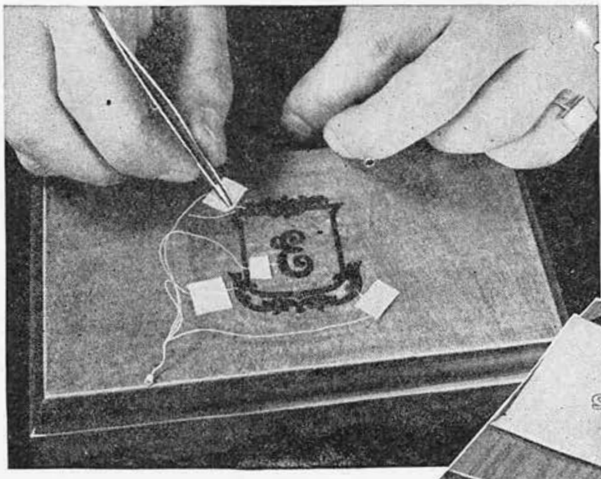
The joint of the lid at the back, where the hinges are, is straight, but the remainder of the joint is scalloped and slightly beveled so as to fit well

INITIALS, designs, or lettering may be plated with any metal on the lid of this novel wooden cigarette container. Although a cigarette box has been chosen as an example, metal-plated designs can be easily applied to any other object by the same method, no matter of what material or composition it happens to be made.

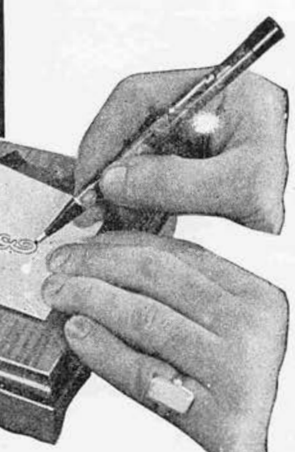
Once you have learned how easy it is to apply decorations of this type, you will see opportunities to use them to ornament many different novelties and gifts. Almost any article you intend to present to another person will be more highly appreciated if it carries an initial or monogram, which can be applied by this plating method in such a way as to enhance the value of the gift considerably.

If you wish to practice the method by constructing a cigarette box like the one illustrated, it will be necessary first to make the box itself. The design is an unusual one in respect to the joint between the lid and the box proper. Indeed, the lid fits so well that the box will keep cigarettes fresh for a much longer time than ordinary containers.

The box in this instance was made of five-ply wood, the parts as follows: Top, 6¼ by 3¾ in., beveled at 15 deg.; 2 sides, each 3 by 4 in.; front and back pieces, each 3 by 6½ in.; bottom, 3¼ by 5¾ in., or an inside fit, according to the thickness of the plywood. First miter the ends of the sides, front, and back at 45 deg. This can be done more accurately by tilting the saw table than by using the jointer. To provide the lid, the pieces are then cut apart on the scroll saw with a fine jig-saw blade. Make the cut 2⅛ in. from the bottom in a straight cut for the back, where the hinges are to be fastened, and with the table tilted to 15 deg. for the sides and front. For the latter three, cut a sheet of paper to the width of the pieces and fold it twice; this may then be cut on a curve so that, unfolded, it forms a template for a design like that illustrated. The bevel cut is important because it makes the completed cigarette box practically air-tight.



When the decoration has been treated with plumbago, fine copper wires are connected to it with adhesive tape



The surface is treated with egg white and the design transferred to it by means of carbon paper

After gluing the parts together, give them a coat of shellac, sand down, and coat the top with varnish. When the varnish is completely dry, coat the top with a solution made from the white of an egg thoroughly mixed with an equal quantity of water. On this surface the design to be metal-plated is traced with the aid of a piece of carbon paper. Remove the paper and carefully go over the design with shellac applied with a narrow, pointed brush. Quick-drying varnish may also be used.

In order to metal-plate the shellacked design, it is next well covered with powdered plumbago (graphite) while still tacky. An alternative method, when there are no fine lines in the design, is to use fine bronze powder. As the surplus of the latter can be brushed off readily from the background, the coat of egg-white solution is not needed. In using plumbago, the excess can be removed from the background with a piece of wet cotton. This loosens the coat of egg albumen and takes with it the plumbago where it does not form a part of the design. Remove this surplus carefully.

By means of small pieces of adhesive tape, fine copper wires are placed in contact with all parts of the design and then connected to the negative pole of a storage battery, or two or three dry batteries. While the latter will serve for small designs, those requiring the deposition of considerable metal can be plated better by the use of a storage battery because of its greater amperage. A layer of cotton is placed over the design and soaked with a plating solution. On top of this put a sheet of the metal to be plated, connected with the positive pole of the battery.

Plating solutions may be purchased, or you can make up your own from the formulas in any of the standard reference books. Inasmuch as copper is a satisfactory

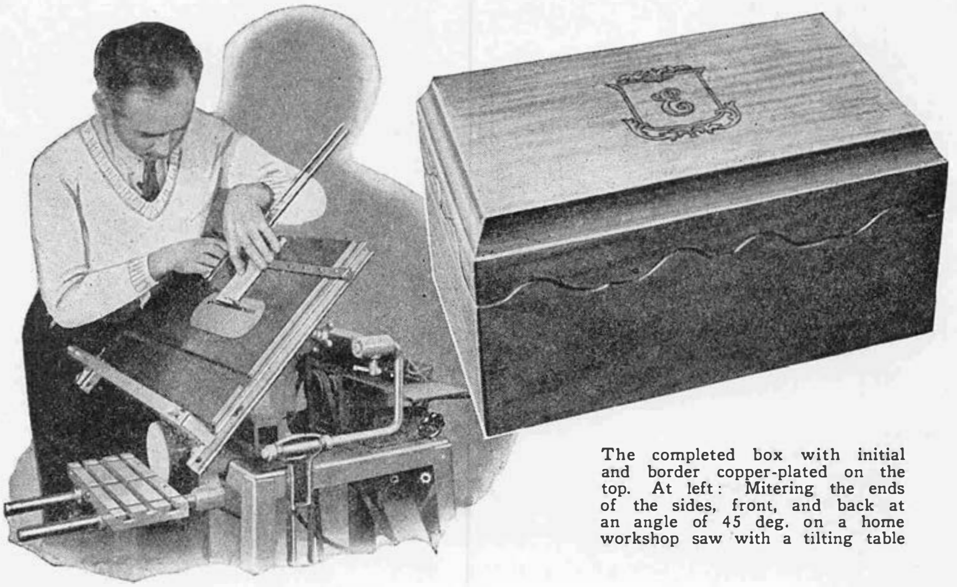
on Wood

A SIMPLE WAY TO DECORATE BOXES AND OTHER CRAFTWORK NOVELTIES

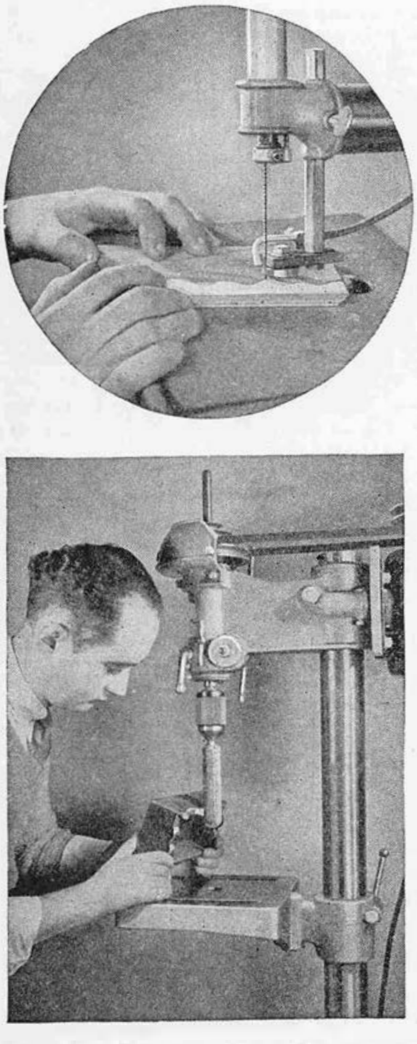
metal for the purpose, giving the appearance of yellow gold, a simple solution of copper sulphate to which has been added several drops of sulphuric acid is recommended.

The length of time required for plating depends on the thickness desired; when a storage battery is used, a half hour is generally sufficient. Then remove the cotton and all connecting wires, wash off all the solution, and dry carefully. The design can be buffed if desired.

Give the entire box a coat of varnish and then polish it with a paste made with oil and rottenstone or very fine pumice. A good way to apply this is by means of the drill press, as shown in one of the photographs. A ½-in. wooden dowel is covered with several layers of felt, treated with polishing paste, and placed in the jaws of the chuck. The drill press should be operated at next to low speed. The shape of the polisher makes it easy to get into the curves. Neat-looking hinges are then added to complete the cigarette box.



The completed box with initial and border copper-plated on the top. At left: Mitering the ends of the sides, front, and back at an angle of 45 deg. on a home workshop saw with a tilting table



The scalloped joint is cut on a jig saw and, after the box has been varnished, the indentations are polished by using a drill press

How to Typewrite Your Name Indelibly on Metal Tools

IMPOSSIBLE as it may sound, you can typewrite your name indelibly on metal. The method is so simple, practical, and inexpensive, that for five or ten cents you can etch your name—and address, too, if you wish—on all of your tools. The lettering cannot be told from typewriting on paper; moreover, it will remain clear and legible for the life of the tool, or whatever metal surface the method is used on.

An electric process is used, and the principle is much the same as for the plating-on-wood process described on this page. However, because of the different material, the technique is not the same.

Obtain from a commercial stationery store a dry stencil sheet intended for making mimeograph reproductions. Do the typing by the usual method, which is explained on the backing sheet attached to the stencil. Be sure that the typewriter ribbon is disengaged so that the bare type will strike the stencil, and that the type is clean. On a clean-cut stencil depends the quality of the finished work. Cut off the part of the sheet upon which you have written, leaving a margin all around.

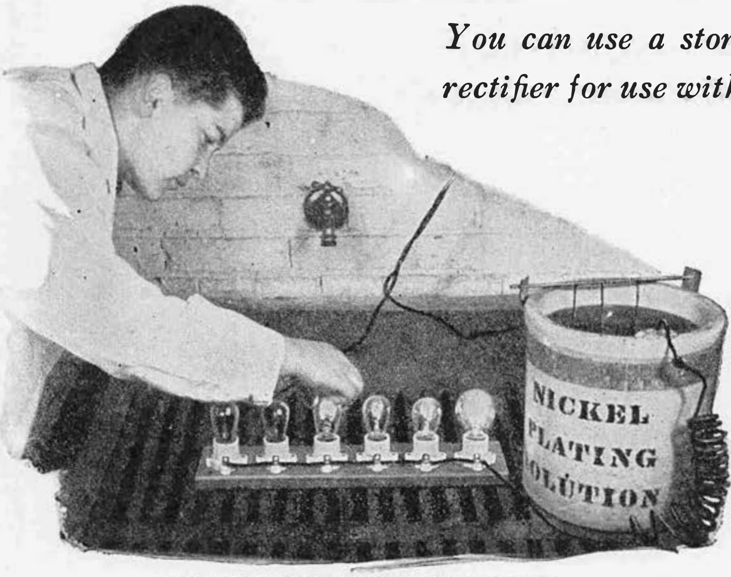
Next, cut a sheet of copper ¼ in. smaller than the stencil. Place this on a sheet of dry cardboard, and on top of it put a sheet of clean, unprinted blotting paper. Mix a saturated solution of copper sulphate, which is made by carefully adding copper sulphate to water until no more is dissolved. With an eye dropper, saturate the blotting paper, then over it lay the stencil so that the typewriting is reversed, or reads backwards. Now clean the tool carefully so that the flat surface to be etched is free from grease. Center it over the lettering on the stencil, and press it into contact with the hands or with a weight.

To supply current for the etching process, you may use a 6-volt automobile battery. Connect wires to the battery from the tool, and from the sheet copper. The negative wire goes to the copper, and the positive to the tool. Allow the current to flow through for from two to five minutes, then disconnect the wires, remove the tool, and wipe it clean and dry. If the contact between the stencil and the tool surface has been perfect, the metal will be etched with an exact reproduction of the typewritten matter, and the engraving will be of such a depth that it will not wear off.

In etching more than one tool, the stencil should be watched carefully. It will last for a large number of impressions, but when the delicate lines are seen to be breaking away, a new stencil must be made. It is a good idea to practice on a piece of scrap metal before etching a prized tool.

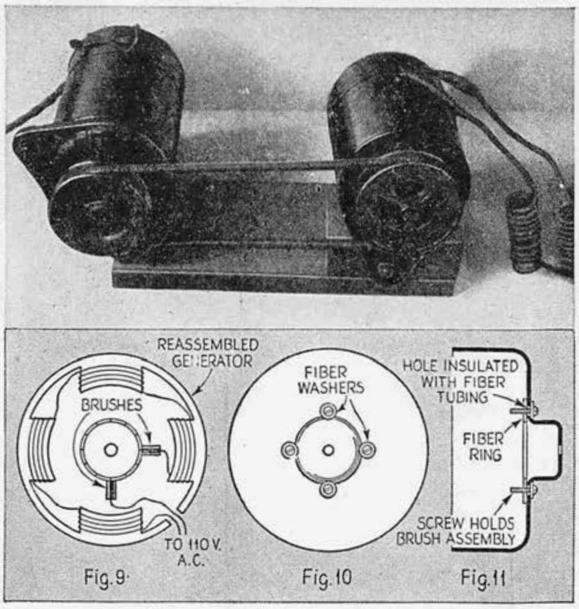
IT'S EASY TO GET THE RIGHT Current for

You can use a storage battery . . . Make a motor-generator rectifier for use with a lamp bank or step-down transformer, or



A SIMPLE LAMP-BANK RESISTANCE

If either 32-volt or 110-volt direct current is available, nothing more is needed for operating a plating outfit than a lamp bank to regulate the current



A 110-volt motor may be made from a discarded automobile generator by the simple changes shown in the diagrams and then used to drive another generator, as illustrated in the photo. Such a motor-generator set supplies up to 15 or 20 amperes

"HOW can I obtain the right kind of current for electroplating at home?" is a question repeatedly asked. There are thousands of home workers who would like to do electroplating, but hesitate because they think that the process requires some special type of current from a complicated power supply. This is a mistaken notion. While it is true that electroplating does require low-voltage, direct current, the necessary apparatus for producing it can be set up without difficulty by any experimenter.

It is not necessary to go deeply into the theory and methods of electroplating, because the subject has been covered repeatedly in the past, and the necessary information is available in many books. In brief, a thin layer of one metal is deposited upon another metal by placing the metal to be deposited, called the "anode," and the object to be plated, known as the "cathode," in a suitable solution. Metallic salts for the more common varieties of plating such as nickel, gold, and silver, may be purchased ready for use from dealers in electroplating supplies, or the solutions for any type of plating may be readily mixed according to the instructions to be found in any standard handbook of formulas. A good tank for plating is a large stone crock like the one shown in the photograph above.

When the positive pole of a direct-current source is connected to the anode and the negative pole to the cathode, the current flowing through the solution will cause a coating of the anode material to be deposited on the cathode, or object being plated. The current required to plate 1 sq. ft. of metal varies from 1 to 12 amperes, depending upon the plating metal and the solution.

Since the resistance of the solution between the anode and the cathode is quite low, some means must be provided to keep the current at the correct level for the object being plated. Where a bank of lamps is used, varying the number of lamps in the circuit will control the amount of current. If the current supply is from a low-voltage source, such as a generator, storage battery, or transformer, a small rheostat should be used to control the current.

When 32-volt or 110-volt direct current is available, the arrangement shown in Fig. 1 is both simple and effective. The lamp bank consists of several lamps, the size of which depends upon the current required. For plating small objects, the lamps should be of 5- or 10-watt size so that a fine degree of regulation may be obtained. To determine the polarity of the supply line, place the two leads that go to the plating tank in a solution of salt water, and small bubbles will rise from the negative lead.

If small lamps are not obtainable, an old radio rheostat, from 6 to 10 ohms, placed in series with the larger lamps will help to control the current.

The set-up in Fig. 2, using a storage battery, a rheostat, and a voltmeter, makes a satisfactory power plant for electroplating. The rheostat should have a resistance of from 2 to 6 ohms and may be salvaged from an old radio. The voltmeter should have a range of 0 to 6 volts, direct current.

While a voltmeter is essential for fine

A CHOICE OF HOOK-UPS

The storage battery and lamp-bank diagram is given in Fig. 1; battery, rheostat, and voltmeter in Fig. 2; various rectifier circuits in Figs. 3, 4, and 5; and an explanation of alternating, half-rectified, and completely rectified current in Figs. 6, 7, and 8

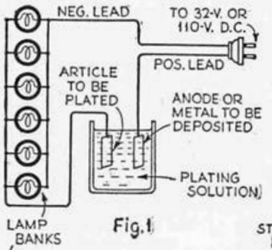


Fig.1

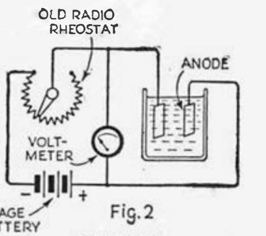


Fig.2

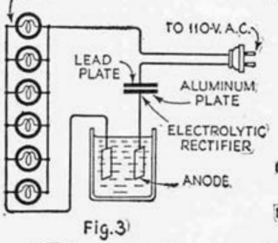


Fig.3

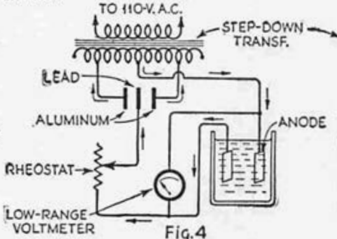


Fig.4

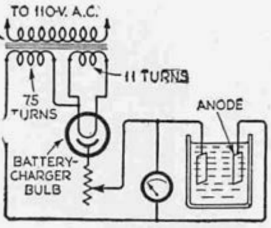


Fig.5

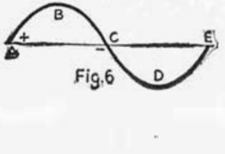


Fig.6

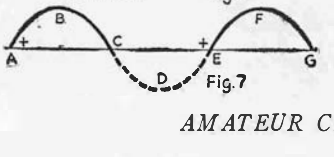


Fig.7

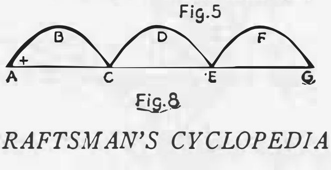


Fig.8

ELECTROPLATING

set from two old auto generators . . . Construct an electrolytic
adopt other simple and comparatively inexpensive methods

work, if one is unobtainable the correct amount of current flowing may be determined approximately by observation when the object to be plated is first placed in the solution. If the object turns dark or black immediately, the current is too high and must be reduced. If the object is not completely covered with a thin coating of the anode material within one minute after being placed in the solution, the current should be increased.

If one of the leads from the storage battery is equipped with a battery clamp, further regulation may be obtained by using one, two, or three cells of the storage battery. To avoid confusion over the amount of current being used and the voltage indicated on the voltmeter, it should be remembered that the voltmeter readings will vary directly with the amount of current flowing between the anode and cathode. Directions for electroplating generally specify the voltage at which the work should be done, the current automatically being correct for that particular voltage.

Where a considerable amount of current is required for plating large areas of metal, a salvaged automobile generator is recommended. When driven by a suitable motor, these generators are capable of delivering a current up to 15 or 20 amperes, which is more than sufficient for the average experimenter's needs. If a driving motor is not available, an excellent motor for the purpose can be made from another automobile generator. In selecting the generators, make certain that they are in good condition, particularly the commutators and bearings.

Practically any type of automobile generator may be converted into a motor by the following method. The drawings (Figs. 9, 10, and 11) illustrate the Ford model-T type because it still seems to be the kind easiest and cheapest to obtain. The same general changes in the generator will be required, regardless of the make, so the experimenter should have no difficulty in applying the instructions to any particular type he is able to obtain.

Remove the brush-holder ring from the end bell, and the third or smaller brush and its holder from the brush ring. Enlarge the screw holes in the end bell and insulate with fiber tubing (Fig. 11). Make four fiber washers to insulate the heads of the brush-holder retaining screws from the end bell as shown in Figs. 10 and 11. Cut a fiber ring to insulate the brush-holder ring from the end bell. The procedure outlined may vary with different types of generators, but the main purpose is to insulate the brush holder assembly from any part of the generator frame.

REASSEMBLE the generator and connect as shown in Fig. 9. One end of the field connects to a line wire, the other end to a brush, and the remaining brush lead to the remaining line wire. The brushes should be exactly 90 deg. apart. Since the leads from the remodeled generator are subject to considerable vibration, it is advisable to attach flexible wires to the brush and field leads that connect to the line wires.

The motor may be connected to the generator with a flexible coupling or by means of the original driving pulleys and a belt. Either alternating or direct current, 110 volts, will serve as the supply. The direction of rotation may be changed by merely interchanging the two wires that connect to the brushes. The generator is connected to the plating circuit as shown at Fig. 2, with the generator replacing the storage battery.

A salvaged radio rheostat having a resistance of from 6 or 10 ohms will serve to regulate the current if only small articles are being plated. If several amperes are required, it will be necessary to provide a rheostat large enough to carry the current without overheating.

When the plating voltage and required current are known, it is an easy matter to calculate the resistance of the rheostat. The plating voltage is subtracted from the supply voltage, and the remainder divided by the required current in amperes. The result will be the value of the resistance in ohms. For example, a plating tank requiring 3.5 volts and 5 amperes is connected to a generator delivering 6 volts. Subtract 3.5 volts from 6 volts and divide by 5, which gives 0.5 ohms as the resistance of the required rheostat. Actually, it would be better to select a rheostat with a range from 0 to 2 ohms so that it could also be used to plate articles requiring less or greater amounts of current.

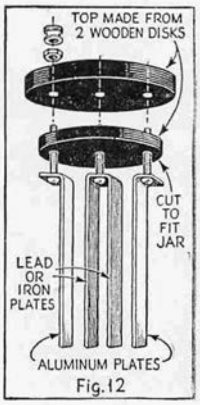
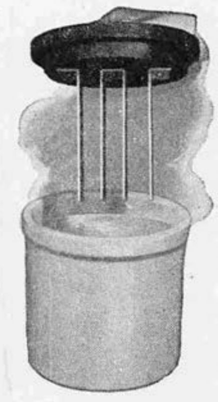
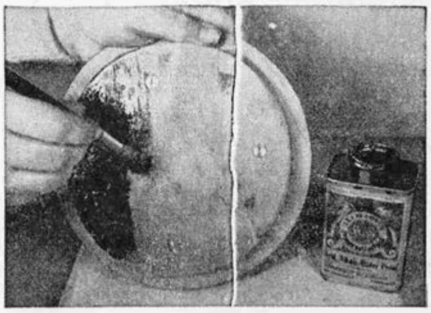


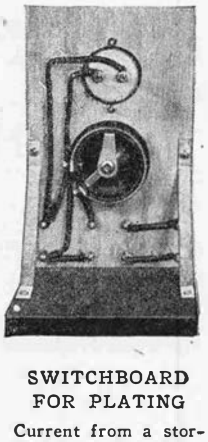
Fig.12





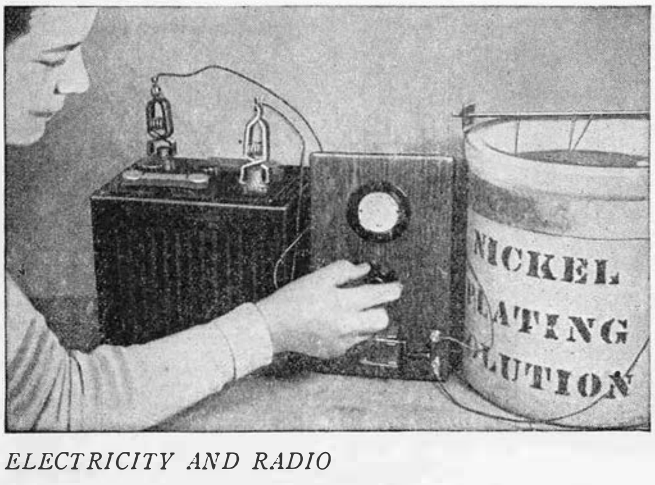
SIMPLE ELECTROLYTIC RECTIFIER

To make this full-wave rectifier, two strips of aluminum and two of iron or lead are fastened to a wooden jar top. Before assembly, the top must be treated with acid-proof paint



SWITCHBOARD FOR PLATING

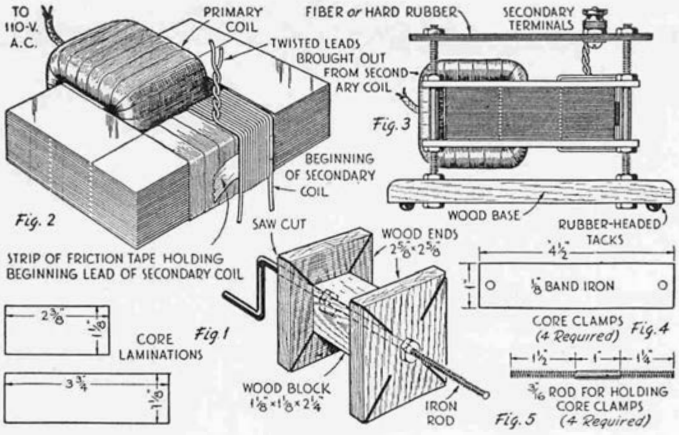
Current from a storage battery may be regulated by means of a rheostat and voltmeter, which are best mounted on a convenient panel. A back view of the panel is shown above, and the complete set-up for plating at the left



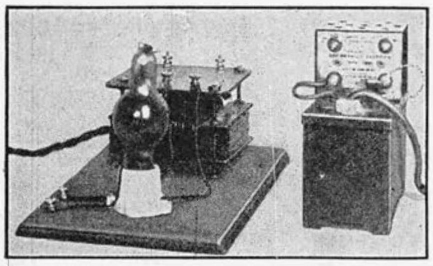
For the purpose of calculating rheostat sizes, the approximate current densities per square foot of surface for the following plating materials will be found suitable for home workshop use:

Chromium	5 to 10 amperes
Copper	6 to 12 "
Nickel	4 "
Brass	6 to 8 "
Bronze	6 to 8 "
Silver	2 "
Gold	1½ "

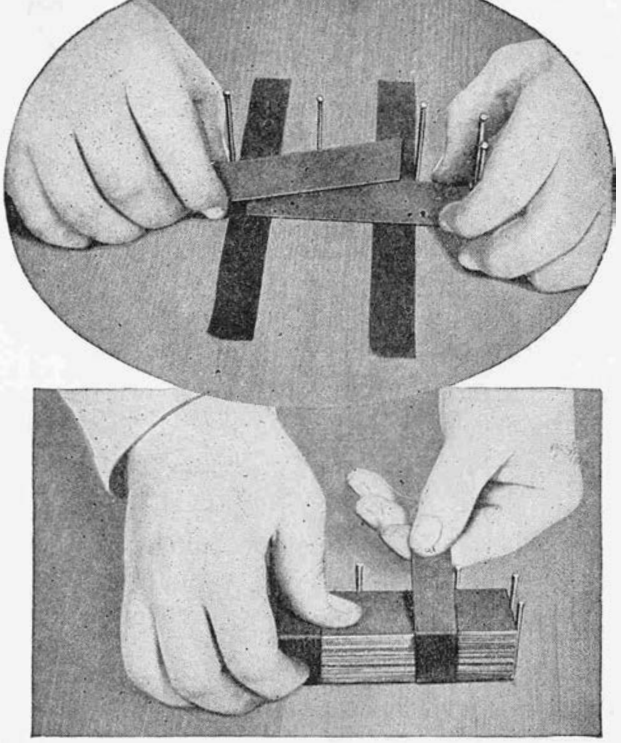
When 110-volt alternating current is available, a simple electroplating current may be obtained by using a bank of lamps and an electrolytic rectifier, as shown in Fig. 3. If more efficiency is desired and a greater current output required, the arrangement of Fig. 4 is recommended. This current-supply system consists of a step-



Core laminations, winding form for the primary coil, a sketch showing how secondary leads are brought out, and method of mounting the whole



Discarded chargers of the type formerly used for radio batteries are excellent for plating



The method of stacking the laminations is shown in the oval. They are bound with tape before being removed from the form

down transformer, a full-wave electrolytic rectifier, a voltmeter, and a suitable rheostat.

A full-wave electrolytic rectifier is constructed by securing two strips of aluminum and two strips of iron or lead to a wooden jar top (Fig. 12). The jar selected should be of glass, porcelain, or stone, and must have a capacity of 2 qt. for each ampere that passes through it. No sizes of the metal strips need be given other than that each should have an area of approximately 15 sq. in. to an ampere. Secure the metal strips to the wood with binding posts. Before assembling the top, paint it with asphaltum or acid-proof paint. Lead is preferred for the inside plates, but if not obtainable, iron will serve equally well. If iron plates are used, it is advisable to lift the cover and plates from the solution when not in use.

Prepare a saturated solution of water and ammonium phosphate, or water and borax. In mixing the solution, proceed slowly, dissolving a little of the ammonium phosphate or borax at a time until the water will absorb no more. Fill the jar to within 2 in. of the top with the solution and set the wooden top in place.

Before using the rectifier it will be necessary to "form" the plates by connecting a 110-volt A.C. line to the posts attached to the aluminum strips. A 60-watt lamp must be connected in series with one of the line wires. The lamp will burn brightly at first, then gradually grow dimmer until there is a barely perceptible glow. At that point the rectifier is ready for use.

The half-wave rectifier shown in the circuit of Fig. 3 is constructed similarly to the full-wave rectifier with the exception that there is only one aluminum plate and one lead or iron plate. The rectifier is "formed" by the same method outlined for the full-wave rectifier, the connections being made to the aluminum and lead or iron terminal posts.

In order to understand the principle of the electrolytic rectifier, it is necessary to remember that alternating current first flows in one direction through a circuit, then reverses and flows in the opposite direction. As indicated in Fig. 6, the current rises from zero potential at *A* to a maximum at point *B*, where it dimishes to zero potential at point *C*. Then it begins to flow in the opposite direction, rises to maximum potential at point *D*, and diminishes to zero potential at point *E*. This complete operation is called a cycle, and the number occurring in one second, usually 50 or 60, is called the "frequency."

Since in electroplating the current must flow in one direction to cause the anode material to be deposited on the object being plated, it can be seen that if we attempt to plate with alternating current, both the plating metal and the object to be plated will alternately act as the anode. Metal deposited from the original anode during half of the cycle will be carried back to it during the last half of the cycle, therefore none will be deposited. If a strip of aluminum and a strip of iron or lead are placed in a solution of ammonium phosphate or borax and connected to an alternating current line through a lamp or resistance, a film of oxide will form on the aluminum strip which will prevent the current from leaving the strip, yet allow it enter from an opposite direction. This principle is used in the full-wave rectifier.

The half-wave rectifier, consisting of a single aluminum plate and one lead or iron plate, is so called because it will rectify only half of the cycle as in Fig. 7.

When the full-wave rectifier is used in conjunction with a center-tapped, step-down transformer, both halves of the cycle are rectified, resulting in a pulsating direct current similar to Fig. 8. The current flows alternately from the lead plate to the other aluminum plate. From each aluminum plate the current flows through the transformer secondary coils in an opposite direction to the center tap of the transformer, where it flows out to the anode of the plating tank in one direction (Fig. 4).

Other rectifiers suitable for electroplating are the types used for charging radio batteries before the all-electric set made its debut. Among these are the kind that uses a gaseous bulb containing a plate and a filament (Fig. 5); and the copper-oxide type, which consists of a series of specially treated copper plates.

Of the different methods of supplying electroplating current which have just been described, probably the one that will have the widest appeal is the system in which an electrolytic rectifier is used. The capacity can be made great enough for all ordinary home-workshop needs, and the necessary materials are cheap, and easy to obtain. It is appropriate, therefore, that a description be given of a transformer for use with the rectifier.

For use with an electrolytic rectifier, a transformer should have two secondary windings, each delivering 6, 8, and 10 volts. This makes it possible to adjust the voltage over an extremely wide range with a single rheostat.

The transformer shown in the illustrations was especially designed to operate in conjunction with an electrolytic rectifier in the circuit marked Fig. 4 on the preceding pages. However, with slight changes, it may be used in connection with a discarded radio-battery type of charging rectifier. Because it delivers current in 2-volt steps, with a range from 2 to 20 volts, it will also be found to be an excellent general utility transformer.

No great mechanical skill is needed in building this power unit, but care should be exercised, especially in seeing that all parts and windings are well insulated. This is more important in the case of a transformer than in connection with most home workshop electrical projects, because if only two turns of wire on the secondary coil happen to make electrical contact, the transformer will be short circuited, and will burn out in a short time.

The first operation in building the transformer is to cut a sufficient number of transformer laminations to make a stack of each size 2¼ in. high when pressed tightly together. Suitable laminations can usually be obtained from burnt-out transformers, but if these are not obtainable, No. 26 gauge stove pipe iron may be substituted. Drive a number of nails into a board to make a form for stacking the transformer core, and place a strip of tape across each end to hold the laminations temporarily in place, as illustrated in a photograph. The nail form should be 4⅞ in. long. Begin stacking the core sections by placing one of the longer laminations against one end of the form, and another long lamination against the opposite end of the form. Continue to stack the long core laminations alternately until half of the total number is used.

Secure the two strips of tape around the assembled core section and carefully remove it from the stacking form. Place the core section in a vise with about 1 in. of the solid portion of the core extending beyond the vise and wrap this solid portion tightly with friction tape. Continue to move outward from the vise and tape about ¾ in. at a time until the whole solid portion of the core section is taped. Wrap a second layer of tape around the core section and coat with shellac. Proceed with the remaining long laminations as above, making two taped sections in all.

Wind 550 turns of No. 22 D.C.C. (double cotton-covered) magnet wire on a wood form to serve as the primary winding. A suitable winding form is shown in Fig. 1. This consists of a wood block 1⅛ by 1⅛ by 2¼ in. and two thin wood ends, 2⅝ by 2⅝ in., held together by a crank-shaped threaded rod. Saw slots from the outer corners, extending toward the center and into the center block to provide for tie wires. Place about 10 in. of any small size wire in each slot in the wood center block and allow them to extend beyond the end blocks. Wrap several layers of thin cardboard around the center block, and proceed to wind the coil. A small piece of pipe placed in a vise will support the form while the coil is being wound. When 550 turns have been wound, bring the ends of the tie wires through the slots in the end pieces and twist them together. Remove the coil carefully from the form and cover with shellac or melted paraffin to serve as a binder. When the binder has hardened, attach a piece of lamp cord to the coil ends, and tape the coil with cotton or friction tape.

The secondary coils are wound directly on one of the taped core sections. Place a strip of friction tape along the core and fold one end back around the starting lead. The following turn of wire will pass over the end of the tape and hold the coil firmly in place. For the transformer having adjustable voltages, wind 11 turns of No. 16 D.C.C. magnet wire on the core section and bring out a twisted lead, as shown in Fig. 2. Wind 11 more turns, bring out another twisted lead, then wind on 33 turns. The end of this 33-turn coil, when twisted with the start of the next coil, will serve as the center tap of the transformer. In winding the remainder of the secondary coil, 33 more turns are required, then two more coils of 11 turns each, with a twisted lead brought out from the end of the 11-turn coil next to the second 33-turn coil.

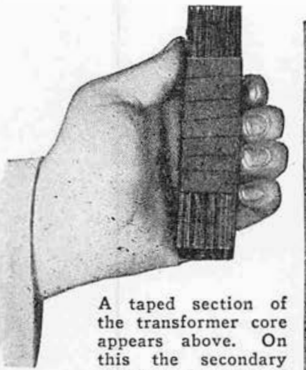
When the winding is complete, there should be two single leads and five double leads extending from the winding. Each layer of winding should be held in place with a strip of tape, as was done with the starting layer. It is advisable to tape the twisted leads where they pass between the turns of wire to prevent a possible short circuit at that point. Tape the winding, place the primary coil over the other taped core section, and insert the short laminations in place, one-half of the total number going on each side. The short laminations are alternately placed in the spaces between the long laminations until all spaces are filled (Figs. 2 and 3).

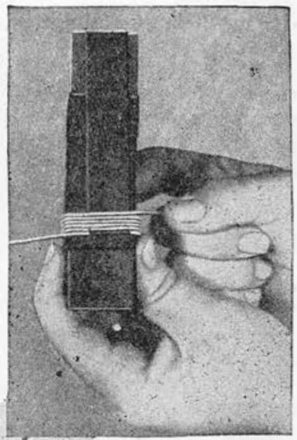
Cut and drill four end clamps (Fig. 4) and provide threaded rods (Fig. 5) to hold them in place. Place the clamps on the core and mount the transformer as shown in Fig. 3. Provide seven terminal screws and connect the secondary terminals to the screws. Mark the terminals to indicate the voltage of each. When not used in conjunction with the rectifier, the transformer makes an excellent general utility transformer delivering from 2 to 20 volts in steps of 2 volts. Approximately ¾ lb. of wire will be required for the primary coil, and ½ lb. for the secondary.

If it is desired to use the transformer in conjunction with a small size, or 2-ampere battery-charger bulb, it will be necessary to wind a different number of turns on the secondary coil. Start the winding as outlined above and wind 75 turns of No. 18 D.C.C. magnet wire on the core. Make a twisted lead and wind 11 additional turns of No. 14 D.C.C. magnet wire. The larger wire connects to the filament circuit of the battery-charger bulb.

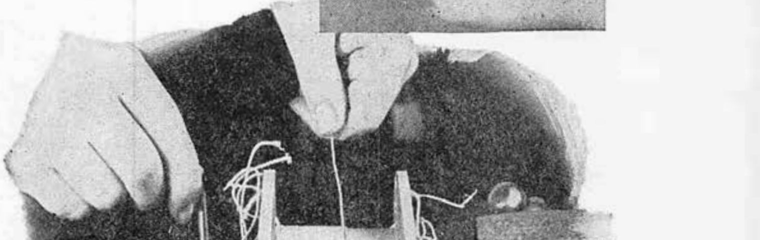
HOW TO LUBRICATE CONDUITS

It is better to blow soapstone or a similar lubricant into a horizontal conduit before the wire is pulled. Where only the wires are lubricated, friction wears off the powder as the wire progresses into the conduit. On combination horizontal and vertical conduit runs with an elbow at the change of direction, pouring soapstone into the elbow from the top of the vertical run also is effective.

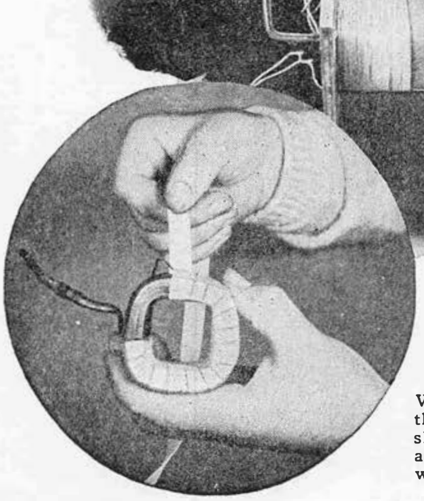




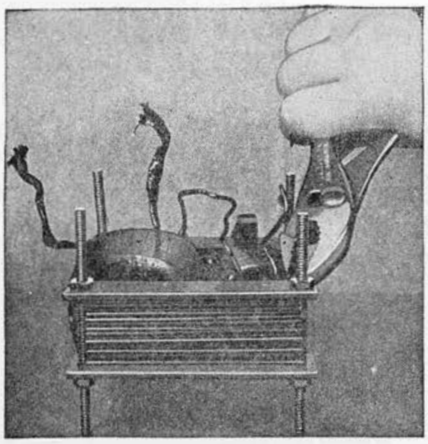
A taped section of the transformer core appears above. On this the secondary winding is started as shown at the right



The primary, which calls for 550 turns, is quickly wound on a form by the method illustrated above



When removed from the form, the winding is covered with shellac or melted parafin and bound, as at the left, with cotton or friction tape



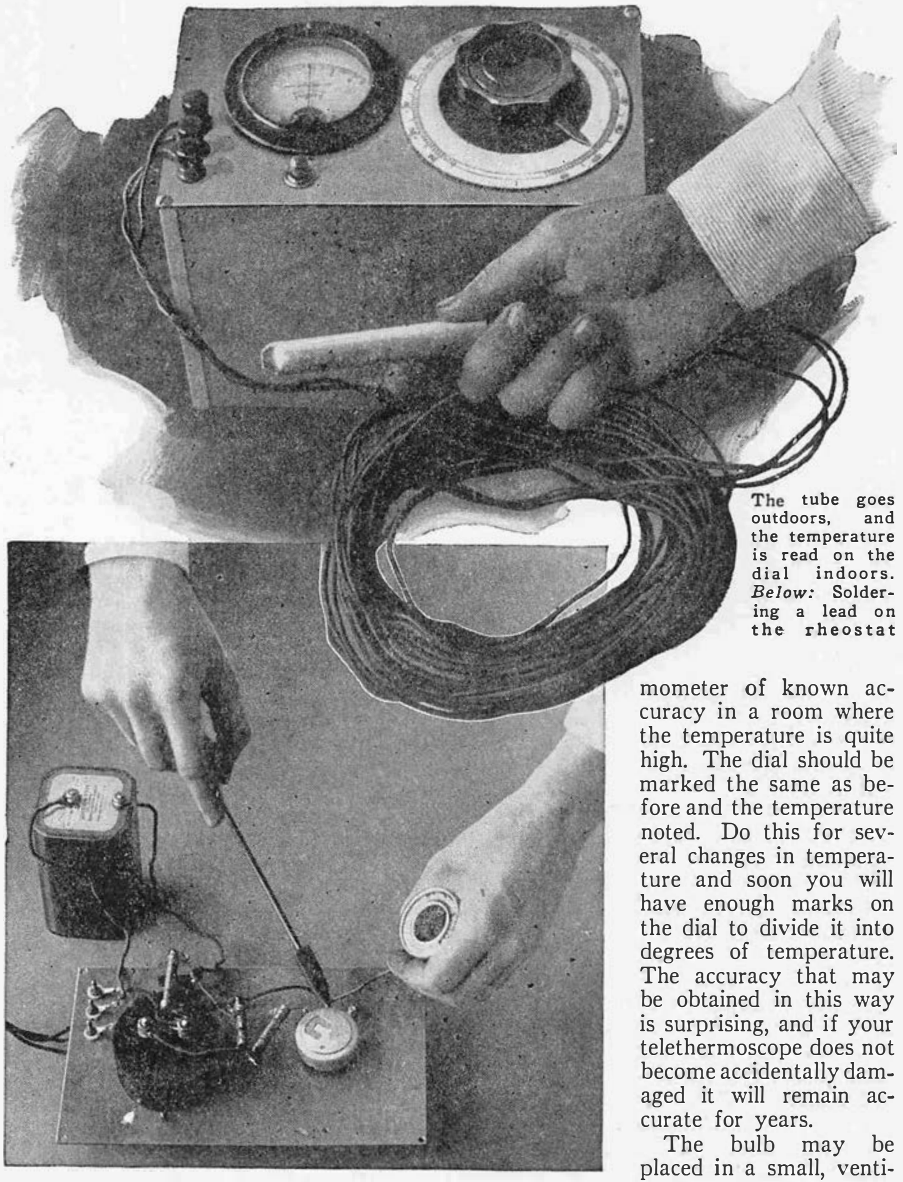
Tightening the end clamps on the core, after which it is necessary to add terminal screws

Placing the end laminations in the core

YOU DON'T HAVE TO GO OUTSIDE TO READ THIS

Electrical Thermometer

HAVEN'T you often wondered during a raging snowstorm how cold it was outside, yet hated to go out on the front porch to read the thermometer? Here is a homemade, remote-reading thermometer, called a "telethermometer" or "telethermoscope," that will give you the outside temperature while you sit comfortably in your room. It is similar to the type used by the United States Weather Bureau at many of its stations. and accurate to a fraction of a degree.



The tube goes outdoors, and the temperature is read on the dial indoors. *Below:* Soldering a lead on the rheostat

The following parts are required: a fairly sensitive galvanometer or 1-0-1 milliammeter, 30-ohm rheostat, dial with pointer, three 100-ohm wire-wound fixed resistors, push-button switch, three binding posts, 5-in. piece of brass or iron tubing of ½-in. inside diameter, a dry cell, and a box to contain the necessary wiring.

Temperature readings are obtained by measuring the resistance of a coil of wire to an electric current. Metal changes its electrical resistance as the temperature of the metal changes. Platinum shows the greatest degree of change but is too expensive. If nickel wire is available, relatively few turns are needed to get the requird 100 ohms resistance at 70 deg. F. Copper is quite satisfactory but approximately 410 turns of No. 36 enamel-covered wire will be necessary.

Wind the coil of wire on mica or any thin insulating material ⅜ by 3½ in., as shown in Fig. 1. Solder leads on the ends of the wire and tape them to the strip to prevent breakage. This unit, called the "bulb," is then inserted in the metal tube, which has previously been lined with waxed paper, and sealed with hot wax, leaving the leads outside.

The indicator, which is merely a resistance-measuring unit known as a Wheatstone bridge, may be built in various ways. The box for this particular model is an alloy can commonly used in radio work, but a well-made wooden box would serve just as well. The galvanometer and indicating dial are set in the top panel, as are the switch and binding posts. Resistance coils, rheostat, wiring, and battery are contained in the box.

Figure 2 shows how the parts should be wired. The bulb is connected to the indicator by a three-wire lead. The extra wire is used to compensate for temperature changes in the lead wires so that only the temperature of the actual copper wire coil will be measured. The leads may be of any length required by the installation.

After the parts are assembled, it is necessary to calibrate the dial—a simple operation. Place the bulb in a dish or pan of cracked ice and allow it to remain there several minutes. Press the button and watch the galvanometer needle. It will swing to one side of the center, showing that the bridge is out of balance. The dial should be turned until the needle points to zero, when the resistance of the bulb and that of the fixed resistor in series with the rheostat are the same. A mark should now be placed on the dial, even with the pointer. This is the point where 32 deg. will be on the dial and should be at about the center of the dial. If it is not, increase the resistance of resistor *A* in the diagram by putting about 2 in. of fine German silver wire in series with it. This may be varied until the freezing point comes about at the center of the dial.

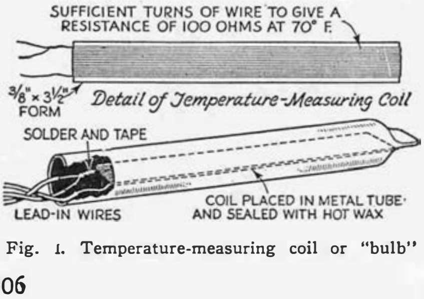

SUFFICIENT TURNS OF WIRE TO GIVE A RESISTANCE OF 100 OHMS AT 70° F.
⅜"×3½" FORM
Detail of Temperature-Measuring Coil
SOLDER AND TAPE
LEAD-IN WIRES
COIL PLACED IN METAL TUBE AND SEALED WITH HOT WAX

Fig. 1. Temperature-measuring coil or "bulb"

Now place the bulb alongside a thermometer of known accuracy in a room where the temperature is quite high. The dial should be marked the same as before and the temperature noted. Do this for several changes in temperature and soon you will have enough marks on the dial to divide it into degrees of temperature. The accuracy that may be obtained in this way is surprising, and if your telethermoscope does not become accidentally damaged it will remain accurate for years.

The bulb may be placed in a small, ventilated box away from the house and connected with the indicator by a three-wire lead (No. 18 or larger). The indicator may be placed anywhere in the house. To learn the outside temperature, press the button and turn the dial until the meter shows zero. The pointer will then be at the correct temperature. Another dry cell may be added if it is desired to make the indicator more sensitive.

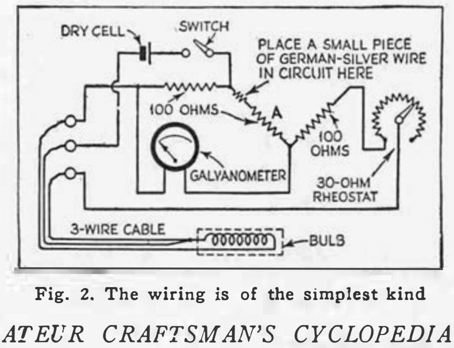
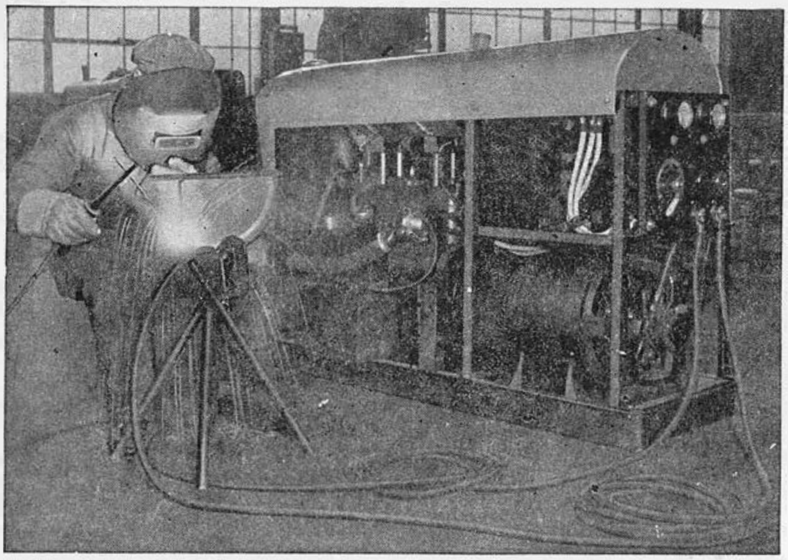
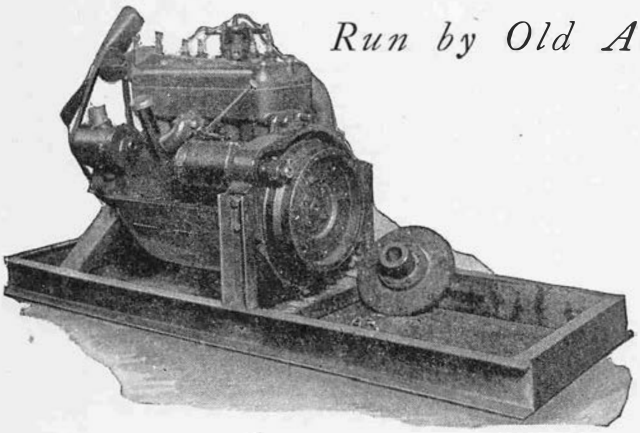


Fig. 2. The wiring is of the simplest kind



SHOP-BUILT Arc Welder

Run by Old Auto Engine



The motor in place. On the floor is a large fiber disk to fit the flywheel, with a steel hub for the generator shaft

NO ITEM of shop equipment is better appreciated than a good arc welding outfit. One can be constructed in the shop that will render excellent service, yet will cost much less than a commercialy built welder.

Electric welding has a decided advantage in that the heat is confined to a very small area, the welding being accomplished instantaneously. The metal does not have to be brought into a molten state before fusion can be accomplished, thus the heat is not radiated over a comparatively large area to cause warping or other damage.

Do not make the mistake of thinking that any old generator may be used for electric welding purposes. The machine must have a capacity of at least 200 amperes at from 25 to 40 volts. This eliminates most lighting and similar type generators. On the other hand, an electroplating generator will often serve very well. If a generator that will meet the above requirements is not at hand, it would be wise to purchase one, along with the necessary electrical controls, from a house dealing in welding equipment.

The side members of the frame are 4-in. channel iron, as are the generator cross supports. The motor supports are 3-in. channel with a specially formed, arch-shaped front member and two upright rear hangers. A crosspiece is placed in the center of the frame to make it rigid.

The motor used in the welder illustrated is a model-A Ford. It has a removable cover on the timing-gear case, and several manufacturers supply a governor that is bolted on in place of the cover. The problem of speed control is thus easily solved.

It will be necessary to borrow an electric welder in order to assemble the parts in a strong manner. Bolting the parts is not recommended. When the frame and its supports have been partly tacked in place by the necessary welding spots, the motor is set up to check the alignment. The front of the motor requires that two pieces of ⅞-in. steel tubing, with a 3/16 in. wall and ⅞-in. long, be welded on top of the arched support to steady the motor. These pieces fit over the motor bolts and seat at the shoulder of the Y-shaped regular motor bracket.

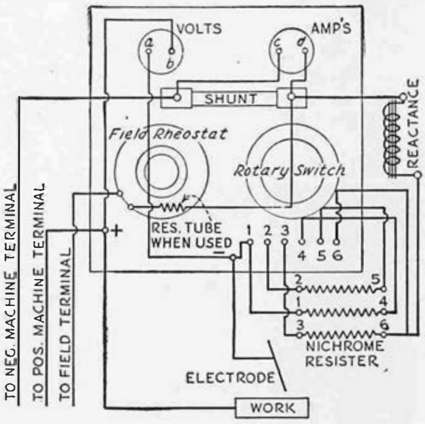
A flexible coupling is used between the motor and generator to absorb vibration and correct any small errors in alignment. The large disk is made of a fibrous nonmetallic material. Eight holes must be drilled and tapped in the face of the flywheel, and must be very accurately laid out. The steel hub fits the generator shaft and is secured with a set screw and a key.

To insure as nearly perfect alignment between motor and generator as possible, a special jig is made, as shown in one of the photos. The generator is shimmed up or moved to right or left until the pointed screws make perfect contact around their circles. The holes for the generator bolts can then be marked with a sharp instrument through the holes.

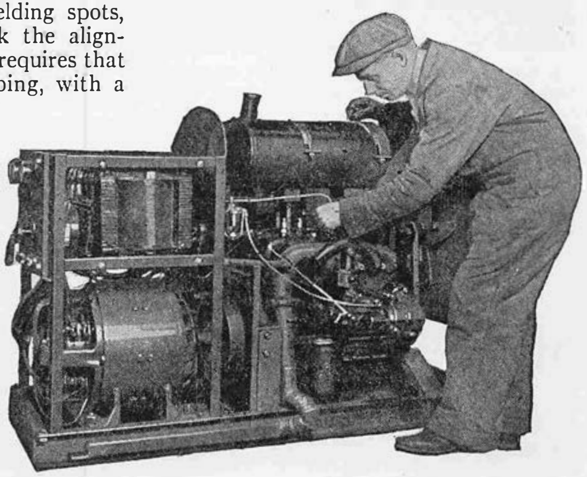
The electrical control unit consists of a panel with ammeter, voltmeter, field rheostat , current selector switch, and terminal posts, and also contains a reactance coil, resistance unit, and various wires and terminal. This complete unit is purchased all assembled and wired in its angle-iron frame. The dimensions of this frame are such as to fit the dimensions of the welder frame as given in the drawing.

The exhaust pipe is carried along the frame by making elbows of steel tubing with welded joints. The tank is obtained in a junk yard and cut down to appropriate in length. The radiator supports are made from 2¼-in. flat stock. A support for the starting crank is also built up on the frame. The radiator is mounted on a block of wood.

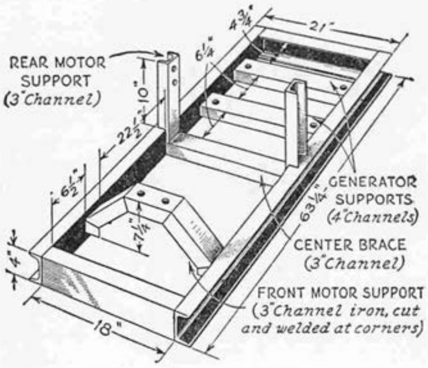
A close-up photo of the motor shows the governor, carburetor, and steel panel installed in back of the motor for the instruments. It has the usual ammeter and ignition switch, and also a button for operating the magnetic starting switch. A support for the carburetor adjusting rod can be seen, and also a sediment bulb. Note the



The wiring diagram. For nonferrous metals, however, the negative side may be grounded



The welder complete except for the hood, which is shown in the photo at top of page. Note how exhaust pipe is extended

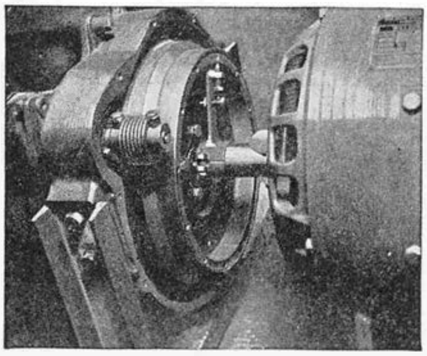

REAR MOTOR SUPPORT (3" Channel)
4¾"
21"
6¼"
10"
22½"
6½"
7¼"
4"
18"
63½"
GENERATOR SUPPORTS (4" Channels)
CENTER BRACE (3" Channel)
FRONT MOTOR SUPPORT (3" Channel iron, cut and welded at corners)

The frame is built of 3- and 4-in. channels, which should be welded, not bolted, together

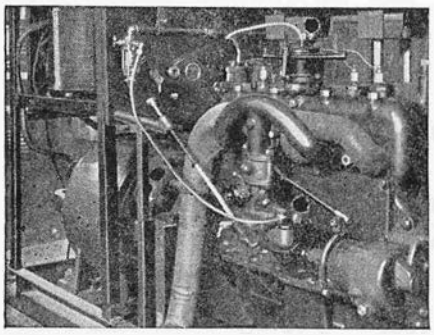
method of connecting governor to carburetor.

A sheet metal covering is constructed over the entire unit, as shown in the photo at the head of this article. This view shows the welding of a steel shop stand and demonstrates just how to hold the electrode and hood. The rubber cables and electrode holder are purchased from a dealer in electric welding supplies. The cable must be capable of handling the heavy current used. Note one cable grounded to work with a C-clamp. In work on ferrous metals (iron or steel), the positive connection is grounded to the work as shown in the wiring diagram. In working with nonferrous metals, however, a reverse polarity is often better.

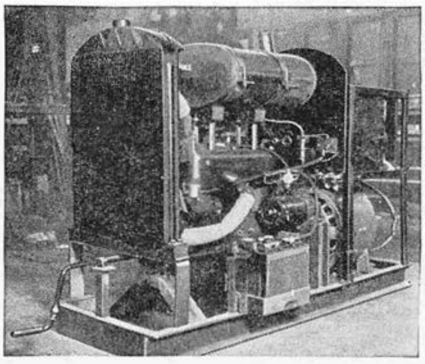
The covering over this welder is painted with gray enamel, and the other parts are painted black. This particular welder is to be mounted on the back of a light truck and used for outside jobs. If only shop work is anticipated, four iron wheels of the type found on two-wheel freight hand trucks and a pull handle should be fitted to the frame.



Alignment is checked with a jig made from steel tubing, flat stock, and bolts and nuts



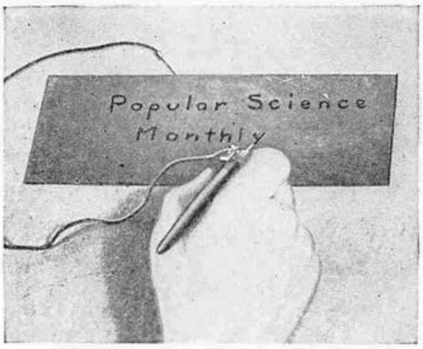
Close-up showing the motor instrument panel and support for the carburetor adjusting rod



How radiator, tank, and battery are mounted. The tank is a junked one, cut down in length

You Can Write on Metal

with this easily made vibrating electric pencil



A battery or a small transformer supplies the current required to operate the pencil

TOOLS and other metal objects may be permanently marked for identification with a homemade vibrating electric pencil of the type illustrated. It may be easily made from odds and ends.

The handle is shaped as in Fig. 1 from a piece of close-grained, round wood, ¾ in. in diameter and 6 in. long. A piece of maple dowel forms an excellent handle, but if it is not available, a satisfactory substitute may be made from an old broom handle. Drill a ⅜-in. hole in the large end of the handle to a depth of 1⅛ in., and a 5/32-in. hole to a further depth of ⅛ in., as shown. Then cut a recess in one side of the handle for the armature spring.

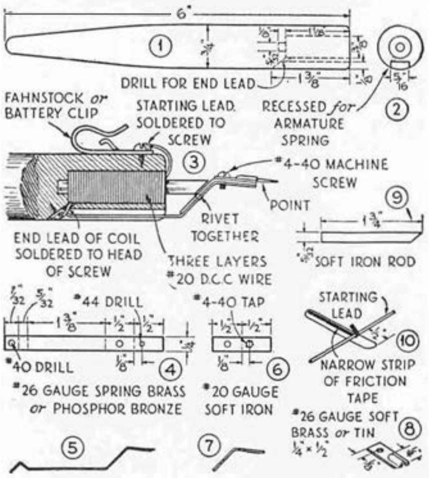
Obtain a piece of soft iron rod, 5/32 in. in diameter, and cut to the size and shape indicated in Fig. 9. A 12-penny nail has an approximate diameter of 5/32 in. and will serve satisfactorily for this piece.

Approximately 6 ft. of No. 20 double cotton-covered wire will be required for the coil.

Place a narrow strip of friction tape along the iron rod, or core, and start the winding ½ in. from the pointed end. The end of the wire is placed over the tape (Fig. 10), after which the end of the tape is folded back over the wire. When the first turn of the coil is completed, it will pass over the folded end of the tape and secure the starting lead firmly in place.

Continue winding until within ⅛ in. of the opposite end of the core. Then fold over the tape and begin the second layer of the coil. As the second layer is started, place a narrow strip of friction tape on the opposite side of the core and proceed as in winding the first layer. Three layers of wire should be wound on the core, with the ends brought out as shown in Fig. 3. Shellac or paint the coil to serve as a binder.

Obtain a piece of No. 26 gauge spring brass or phosphor bronze, ¼ in. wide and 2¾ in. long. Mark off sections and drill as shown in Fig. 4. This piece, together with those shown in Figs. 6 and 8, serves as the armature and point holder. Drill all the holes with a No. 40 drill, except where a No. 44 drill is indicated. Shape the spring as shown in Fig. 5. Cut a piece of No. 20 gauge soft iron to the size shown in Fig. 6, drill and thread as indicated, and bend to the shape shown in Fig. 7. Rivet pieces 5 and 7 together with a piece of soft iron wire, as shown in Fig. 3.


6"
①
¾"
1⅛"
1⅜"
5/16"
DRILL FOR END LEAD
②
RECESSED for ARMATURE SPRING
FAHNSTOCK or BATTERY CLIP
STARTING LEAD SOLDERED TO SCREW
③
#4-40 MACHINE SCREW
POINT
RIVET TOGETHER
END LEAD OF COIL SOLDERED TO HEAD OF SCREW
THREE LAYERS #20 D.C.C WIRE
⑨
1¾"
SOFT IRON ROD
7/32"
5/32"
#44 DRILL
1⅜"
½"
½"
#40 DRILL
⅛"
④
#26 GAUGE SPRING BRASS or PHOSPHOR BRONZE
#4-40 TAP
⑥
#20 GAUGE SOFT IRON
STARTING LEAD
⑩
NARROW STRIP OF FRICTION TAPE
#26 GAUGE SOFT BRASS or TIN ¼" × ½"
⑧
⑤
⑦

The handle, the assembled working point, and details of armature, spring, and other parts

A piece of No. 26 gauge soft brass or tin should now be cut to the size shown in Fig. 8. Drill as indicated and bend so as to form a groove for holding the needle or copper point securely to the armature. Secure the needle holder to the end of the armature with a No. 4-40 machine screw.

Insert the coil in the handle and bring the starting lead to a small Fahnstock or battery clip, as shown in Fig. 3. A clip taken from an old radio "B" battery will serve. When securing the clip to the wooden handle, take care that the wood screw does not extend into the coil. The end lead of the coil should be brought out through a small hole previously drilled from the spring recess to the end of the large hole in the handle.

Fasten the armature to the handle with a small wood screw, and solder the end lead of the coil to the screw, as shown in Fig. 3. Glue a piece of tape or thin cardboard over the spring recess.

The point may be an old phonograph needle or a pointed piece of copper wire, but since the effect of each varies on different metals, it is advisable to experiment with both.

In using the pencil, one wire from the source of supply is connected to the article to be marked, and the other wire is connected to the clip on the pencil. From four to six volts will be required to operate the pencil.

HOME SCIENCE

An Easily Made Sextant

That Shows How Ships Find Their Way By the Sun and Stars

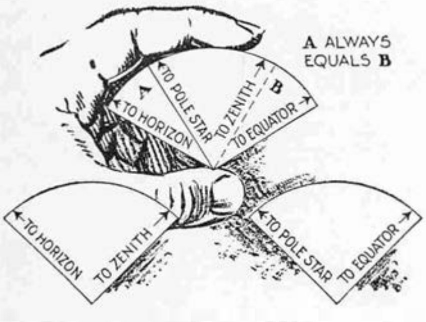


Diagram showing how simple sextant is used to determine latitude from polestar

IF YOU have crossed the ocean, you probably have seen the ship's captain, or his first officer, "shooting the sun." Shortly before noon, he came out on the bridge, sighted toward the horizon for a couple of minutes through an odd-shaped instrument, and disappeared into his chart house.

Had you been watching the bridge at night, you might have seen the same performance repeated while the officer on watch took the altitude of the North Star above the horizon.

In each case, the officer used the mariner's sextant to determine the north and south position of the ship on the earth, or, in other words, to find its latitude at the time the observation was taken.

With a well-made sextant, in experienced hands, the latitude of a ship can be determined by the sun and stars, with surprising accuracy, the margin of error not exceeding a mile or two. This information, plus that furnished by the ship's compass and chronometer, enables the captain to hold a true course, and, if necessary, go straight to any position radioed by a ship in distress.

Since finding the latitude of a ship at sea is the outstanding application of astronomy to everyday human affairs, everyone should know something about it.

Before we start the job of making a rough cardboard sextant, we must understand why the sun and the North Star, as well as other heavenly bodies, can be used to determine north and south positions on the globe.

In order to illustrate the principle clearly, let us refer to our umbrella upon which star positions are marked and the rod of which represents the polar axis of the earth. The earth itself can be an old tennis ball, split in half, and placed around the umbrella rod, as shown in the illustration. The black band around the ball stands for the earth's equator.

Since it is a little easier to catch on to the way the polestar is used in latitude observations, let us begin with Polaris rather than the sun.

A pin is stuck into the ball through a little disk of cardboard to represent an observer on a ship that is halfway between the earth's pole and the equator. The edge of the disk represents the observer's horizon in every direction. Since the world's curvature is only a few inches to the mile, the comparatively small circle of sea visible from a ship can be regarded as approximately flat, as our disk is.

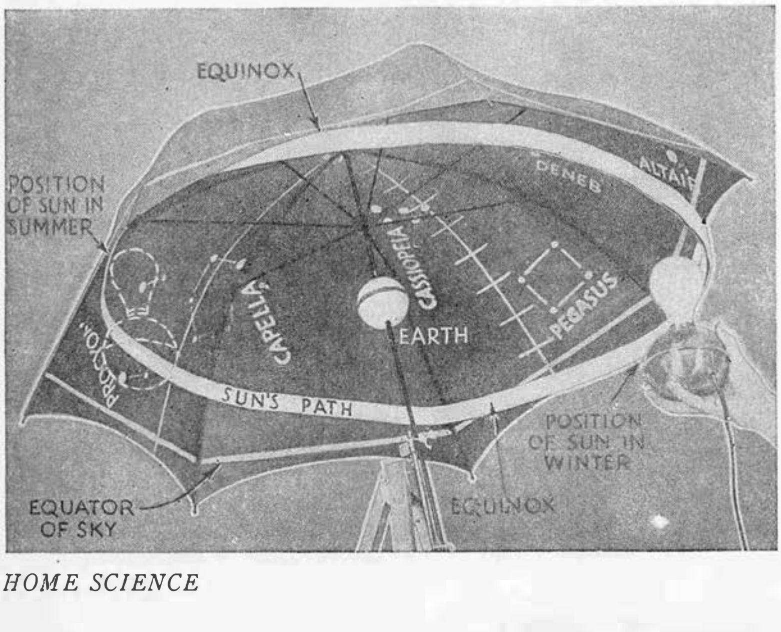
Since our earth is a mere grain of sand in comparison with the millions of miles to the polestar, any line parallel with the earth's axis will point just as close to the polestar as the line of the axis does. For our rough and ready purpose, let us say that our umbrella-rod axis points directly to the infinitely remote polestar. Accordingly, a line parallel to it from our observer will also indicate the star.

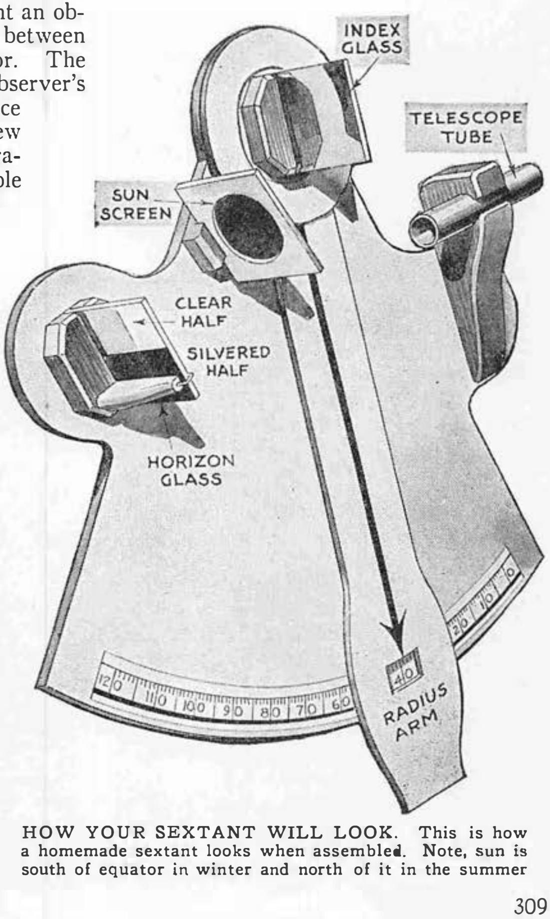
For the same reason, it follows that plane drawn parallel to the earth's equator through the observer will cut the starry globe of the sky along the same circle as the plane of the earth's equator itself does. If you think of the earth as a grain of sand in stellar space, you will have no trouble in getting this idea.

With this point settled, it is easy to see how latitude is found from an observation of the polestar's height above the northern horizon.

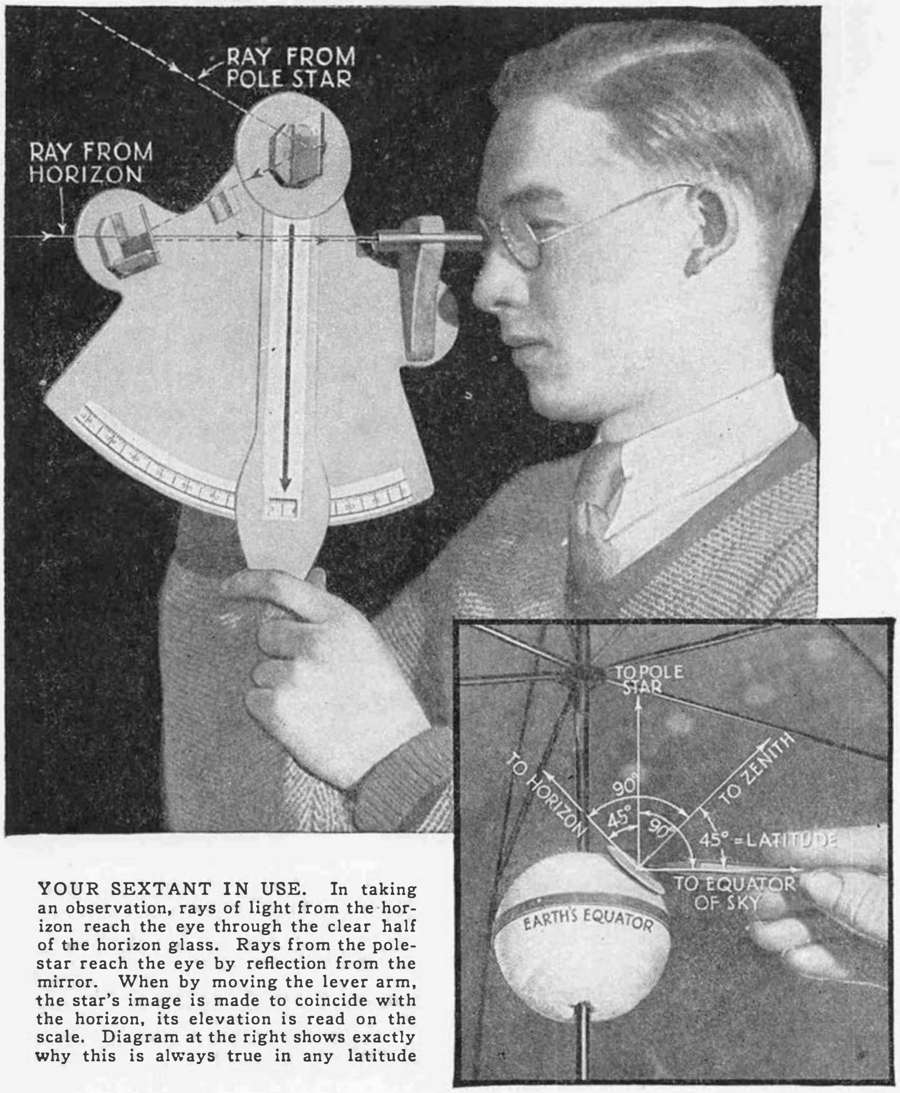
It is plain that the observer's line of sight to the polestar makes a right angle

UMBRELLA SOLVES LATITUDE PROBLEM. In the picture below, the earth's orbit around the sun is indicated by the cardboard hoop. The plane of the earth's equator and its prolongation among the stars is indicated by the black line on the ball and chalk line on umbrella, which is tilted in line with earth's axis





HOW YOUR SEXTANT WILL LOOK. This is how a homemade sextant looks when assembled. Note, sun is south of equator in winter and north of it in the summer



YOUR SEXTANT IN USE. In taking an observation, rays of light from the horizon reach the eye through the clear half of the horizon glass. Rays from the polestar reach the eye by reflection from the mirror. When by moving the lever arm, the star's image is made to coincide with the horizon, its elevation is read on the scale. Diagram at the right shows exactly why this is always true in any latitude

with his line of sight to the equator of the sky. It is also apparent that his horizon is at right angles to the zenith, a point directly over his head.

Now cut two accurate quarter circles from a sheet of writing paper and a moment's experimenting with them will quickly show you how latitude is found. First label the edges of the quarter circles as shown in the drawing and then hold them up toward the light with their curves and points coinciding.

As you now hold the quarter circles against the light and rotate them upon each other around their common center, you will notice that the angle between the line to the polestar and the line to the horizon will always exactly equal the angle between the line to the zenith and the line to the equator. As the first angle is increased in size, the second increases with it, and vice versa.

You can now see that as soon as our observer has measured the angle of the polestar above his horizon, he has also measured the distance of his overhead point, or zenith, from the point where the plane of the earth's equator cuts the sky. This means that he has found his latitude, for latitude is simply his distance north or south of the equator.

Suppose our observer finds that the polestar is forty-five degrees above the horizon. Then he knows at once that his position is forty-five degrees north latitude.

If the sun crossed the sky every day in the exact plane of the earth's equator, a skipper could find his latitude from it almost exactly as he does from the polestar. After measuring with his sextant the height of the noon sun in degrees above the southern horizon, he would need only to subtract this from ninety degrees, the distance from his zenith to his southern horizon. The number of degrees remaining would be his latitude.

The sun, however, only crosses the sky in the plane of the equator on two days of the year—once in the spring, and again in the fall. On all other days, its path is at a constantly varying distance north or south of the equatorial plane. Accordingly, a skipper must correct his observation of the sun's height by the distance that the sun is north or south of the equatorial plane on that day. This difference is called the sun's "declination" and is given for every day in the year in the Nautical Almanacs published by all governments that have navies or mercantile shipping.

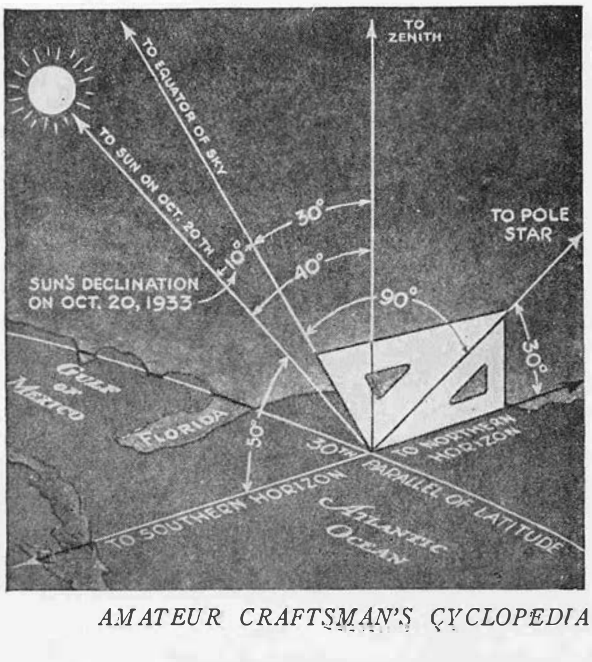
In summer, when the sun's declination is north of the equator, the correction must be *added* to the distance between the sun's position and the zenith, in order to obtain the latitude. In winter, when the sun's path runs south of the equator, the declination is *subtracted* from the distance between the sun's position and the zenith.

The photo-diagrams and scale plan shown on the first page of this article, give all the measurements and arrangement of parts necessary to build a model sextant, with which you can find the approximate latitude of your home. You can do this by taking the altitude of the North Star or the sun. In employing the sun, observe it for a couple of minutes before noon. The sun's distance from the horizon will increase slowly until it is exactly on the meridian. After that it will decrease. The mariner's object, and yours, is to measure the sun's angular distance from the horizon when it is at its highest point.

To do this, look at the horizon through the telescope tube on the sextant. Then move the radius by its handle until the sun comes into your field of view. Move the handle gradually as the sun ascends to the meridian, keeping the sun on the horizon line. When the sun ceases to rise, stop observing and read the figure from your sextant's scale.

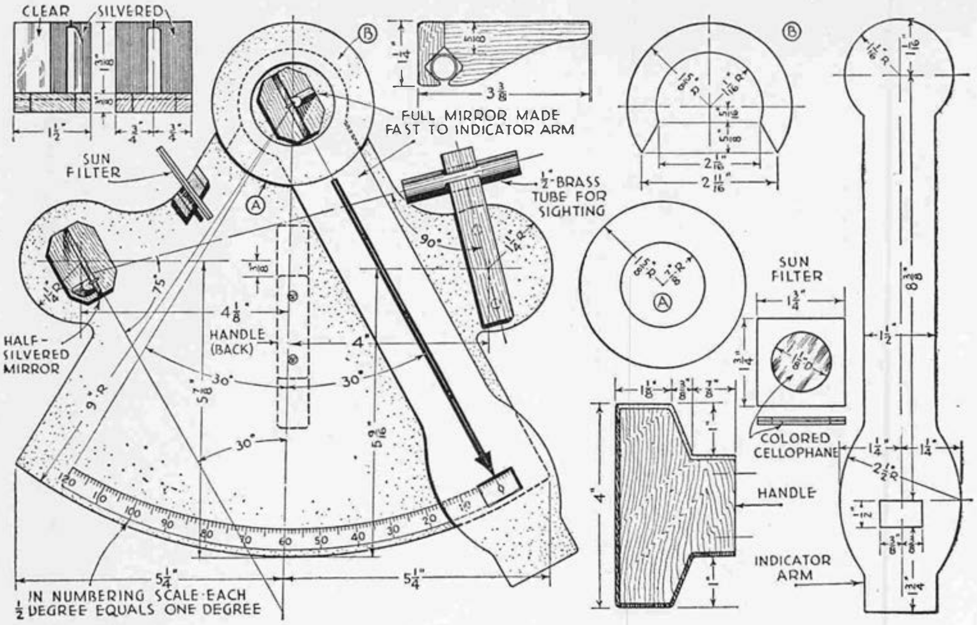
When you have read this angle on the scale of your sextant, subtract the number of degrees from ninety. This gives the sun's zenith distance. To this add or subtract the sun's declination for that day, depending upon whether the sun is north or south of the equatorial plane.

If you make your observation on Sept. 23 or 24, you can neglect the sun's declination as it is then crossing the equator, and the correction is less than one-sixth of a degree.



SHIP'S CAPTAIN FINDS LATITUDE

If a ship's officer wanted to find his latitude off northern Florida on next October 20, he would shoot the sun at noon and find it fifty degrees above the horizon, or as the diagram shows, forty degrees from the zenith. As the declination of the sun on that date will be ten degrees, the officer subtracts to get latitude



Drawing of parts and dimension necessary in making your own sextant

In observing the sun, you will of course need some sort of a dark screen to protect your eyes from the glare. A satisfactory screen can be made by fastening eight thicknesses of green cellophane together between small cardboard masks, and attaching the screen to the sextant in the path of the sun's rays reflected from the index mirror to the horizon mirror. You can, however, use a piece of glass smoked in a candle flame, and protected by another plain glass fastened over it.

The sextant's construction and principle of operation are made sufficiently plain in the illustrations. It is necessary only to add a word of caution. Be sure to reinforce the cardboard frame so that it will remain flat, or build it from laminated wood. Also take care that the two mirrors are perpendicular to the frame and parallel to each other when the arrow points to zero on your sextant's scale of angles.

It is better to make the degree scale on a separate pice of Bristol board and attach it after the mirrors are actually parallel. It is easy to prove that they are in this condition by sighting at a distant telephone pole or steeple and moving the radius arm gently until the two images of the object blend into one. Then attach your scale with glue, and your sextant will be correctly adjusted for altitude observations.

The horizon glass is easily prepared by scratching off the silver from its upper half. The index mirror is left fully silvered.

After placing the circular head of the radius arm in its cardboard socket, a pin should be run through the center and bent over on the back to act as a secure bearing.

The telescope is merely a small piece of brass tubing to direct your eye at the proper angle. In a professional sextant, this telescope, of course, contains lenses.

With care in constructing your model, you can determine your latitude with fair accuracy from the polestar or sun. However, unless this is done over water, you should select a location where there are no hills on the horizon.

It is needless to say that this article makes no attempt to enter into the fine points of the astronomy of navigation. As a matter of fact, the polestar is about two degrees distant from the pole, and the aim has been merely to make the principles plain by making use of them in practice, and thus give you the thrill of finding your approximate position upon the earth's surface with no other aid than the sun and stars.

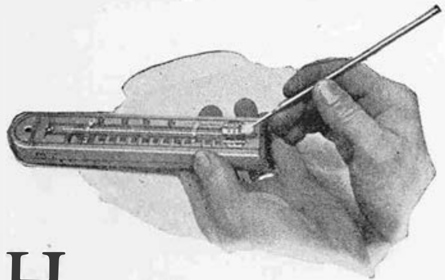
SUN'S DECLINATION

Distance North or South of Equator
at Weekly Intervals

+ *sign means Sun is North of Equator*
— " " " " *South* " "

Sept. 1	.......+8	degrees 53	minutes
Sept. 8	.......+5	" 57	"
Sept. 15	.......+3	" 17	"
Sept. 22	.......+0	" 35	"
Sept. 29	.......—2	" 8	"
Oct. 6	........—4	" 51	"
Oct. 13	........—7	" 31	"
Oct. 20	.......—10	" 6	"
Oct. 27	.......—12	" 33	"

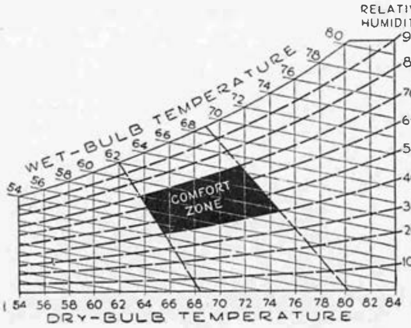
Whirling Thermometers Measure Humidity



HUMIDITY—the amount of water vapor in the air—is such an important factor in maintaining comfort and good health that more attention should be paid to its control. Here is an easily constructed instrument (sling psychrometer or hygrometer) that will indicate the percentage of relative humidity.

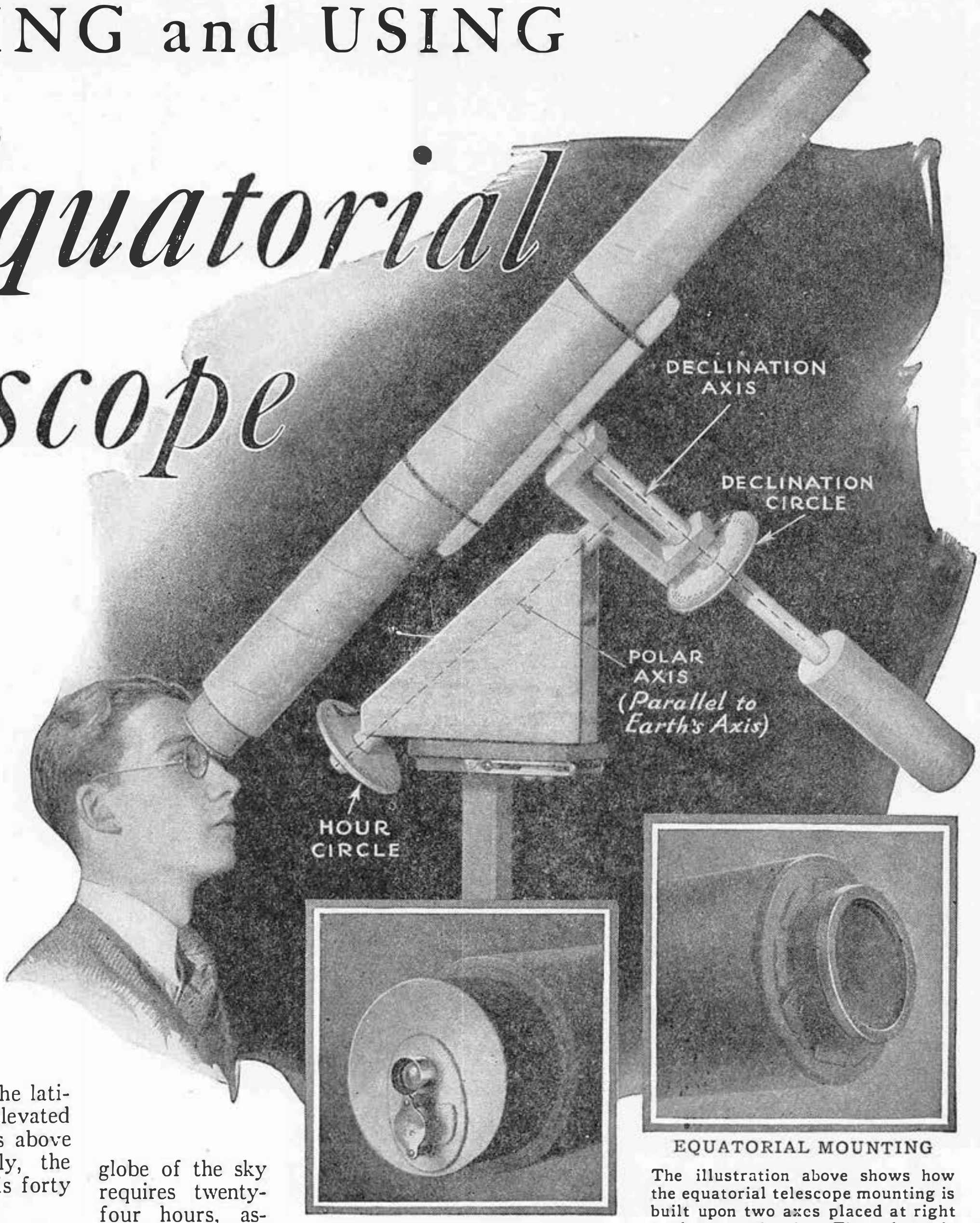
Obtain two similar thermometers and fasten them together, back to back, with wood screws. Under the bulb guard of one thermometer stuff a small wad of cotton. Drill a ¼-in. hole through both thermometers at the top. Fashion a handle about 6 in. long and fasten this to the thermometers with a wood screw. Insert a washer between the handle and the thermometer, but do not tighten the screw all the way.

Moisten the wad of cotton with a few drops of water. Then whirl the assembly for half a minute and note the temperatures on both thermometers. The wet bulb should now read a lower temperature than the dry bulb, due to the fact that heat is required to evaporate the water. On the chart at the end of this article, locate the dry bulb temperature at the bottom. For example, this might be 70 deg. Locate the wet-bulb temperature at the top, where it is indicated by the diagonal lines. Assume this as 61 deg. Now trace these two lines until they intersect. From this point follow the nearest curved dotted lines out to the right of the chart, where the percent of humidity may be read. In this case it is 60 percent. This is within the comfort zone in the chart and indicates good humidity. The shaded area is the comfort zone for winter, and will tell whether the water pan on the furnace or other air-conditioning devices are operating with the desired efficiency.



MAKING and USING

An Equatorial Telescope



EQUATORIAL MOUNTING

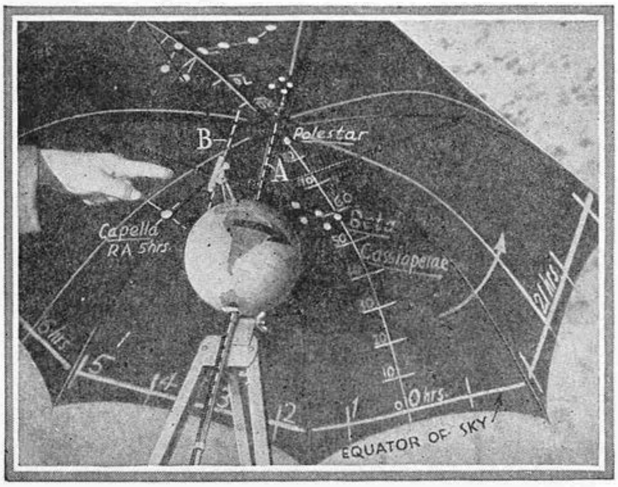
The illustration above shows how the equatorial telescope mounting is built upon two axes placed at right angles to each other. The polar axis is parallel to the earth's axis and the declination axis cuts it at right angles. In following a star's motion the telescope turns on the polar axis. Inset above, telescope's object glass made from camera's portrait attachment. Left, eye piece made from pocket lens magnifier with short focus

AFTER making and using the sextant described in this book, it will be easy now for you to build an astronomical telescope with an equatorial mounting. Let us consider the mounting first, for you may already have a telescope of some kind, or you may prefer to buy one rather than make the simple one to be described. The mounting is necessary in either case.

This equatorial mounting is used in all professional observatories as it enables the telescope to follow any star steadily by turning upon an axis parallel to the polar axis of the earth. As you already know, the earth's axis points approximately to the North Star, so the axis of our equatorial mounting must do the same. In the latitude of New York, the polestar is elevated at an angle of about forty degrees above the northern horizon. Accordingly, the slant of our telescope's polar axis is forty degrees.

Look at the three pictures showing the miniature model of an equatorial telescope attached to a globe and you will see how the slow turning of the telescope from east to west on its polar axis enables an observer to keep any star in view for twenty-four hours.

Since the complete rotation of the globe of the sky requires twenty-four hours, astronomers decided to locate the east and west positions of stars by great imaginary circles drawn, at hourly intervals, through the poles of the sky, at right angles to its equator. In our pictures some of these meridian lines (called "hour-circles") are represented by the ribs of the umbrella.



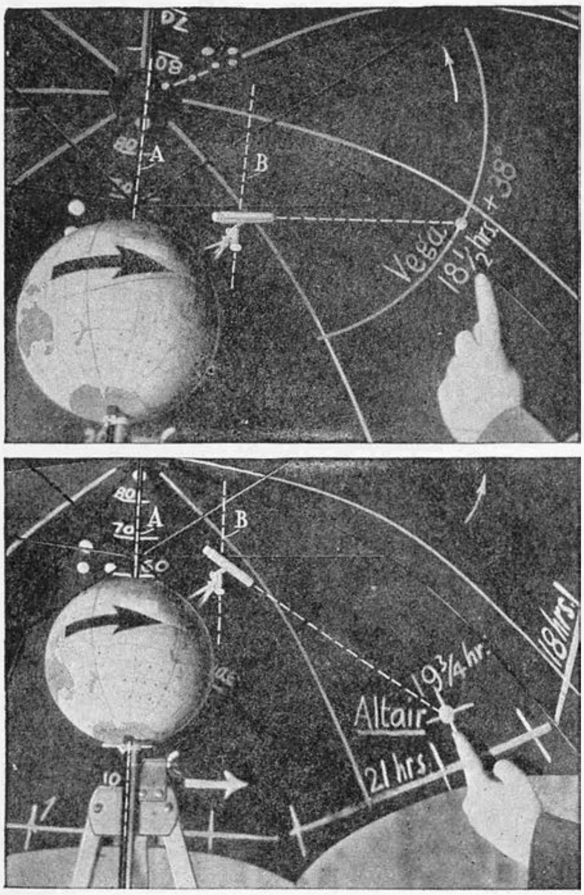
HOW ASTRONOMERS LOCATE THE STARS

Astronomers use a line passing through the polestar and Beta Cassiopeiae as the zero-hour line of the skies. Twenty-four one-hour divisions are measured from this line on the sky's equator from west to east. The hour line passing through a star is called its "right ascension." Its "declination" is its distance in degrees north or south of the equator. The right ascension of Beta and Capella is zero and five hours respectively. Beta's declination is 60 degrees. "A" is polar axis of earth, "B" polar axis of the telescope mounting

It was also decided that the starting line should be the circle passing through the polestar and one of the stars in the "W"-shaped group called Cassiopeia. Another illustration shows how the hour circles are marked off on the equator all the way round the sky, from zero hours to twenty-three hours. Twenty-four hours is of course identical with zero hours.

To see how an equatorial mounting works, let us imagine that an astronomer points his equatorial telescope at the star Beta Cassiopeiae, which is exactly on the zero hours circle, and starts the clockwork which turns the telescope westward on its polar axis while the earth turns eastward. All night the clockwork will keep Beta Cassiopeiae in the telescope's field of view. When the sun rises, the instrument will still be pointed at the star's position, and when darkness comes again, Beta Cassiopeiae will still be in the tele-

Homemade Instrument, Magnifying 100 Times, Is Easily Put Together of Odds and Ends Found in Any Home



HOW TO FIND STAR'S POSITION. The model telescope in the pictures above is used to show how you can find the position of a star even in bright daylight. On a September evening, turn the telescope upward until the declination pointer indicates the figure 38. This is Vega's declination. Then adjust the hour circle on its polar axis until the pointer indicates 18½, which is Vega's right ascension. Now turn the hour circle pointer to 19¾ which is Altair's right ascension. When the pointer is turned to eight degrees, it will indicate Altair

scope's field of view. The instrument will still be pointed at the zero hours line, after following it completely around the sky for twenty-four hours.

This refers to a circumpolar star which never sets in the latitude of New York, but the same thing would hold true of any other star. The following evening the telescope would be pointed at the same spot in the heavens, after turning completely round upon the polar axis of its equatorial mounting.

Of course, only very expensive telescopes are provided with clockwork to drive them, but the equatorial mounting is just as great a convenience to the amateur stargazer, for it enables him to follow a heavenly body very easily with his telescope.

Also, after the hour-circle dial on the polar axis is set so that the pointer indicates zero hours on the dial (while the telescope is pointed at Beta Cassiopeiae) the telescope can then be pointed to the hour circle of any other star in the sky by turning the pointer to the correct figure on the hour-circle dial of the mounting. After this, the star can be brought into view by turning the telescope north or south upon its "declination axis" until the "declination pointer" indicates the star's proper declination.

Declination on the sky is equivalent to latitude on the earth, which is why the declination of the polestar or sun enables us to compute our latitude.

The east and west distance of a star from the zero hours circle (called its "right ascension") is also similar to longitude on the earth. The difference is that longitude is measured in hours east or west of the earth's meridian which passes through Greenwich, England, while right ascension is measured continuously eastward from zero hours completely around to zero hours again. This measurement eastward is called "right ascension" because, when you face the northern horizon, the stars always ascend above the eastern horizon on your right hand.

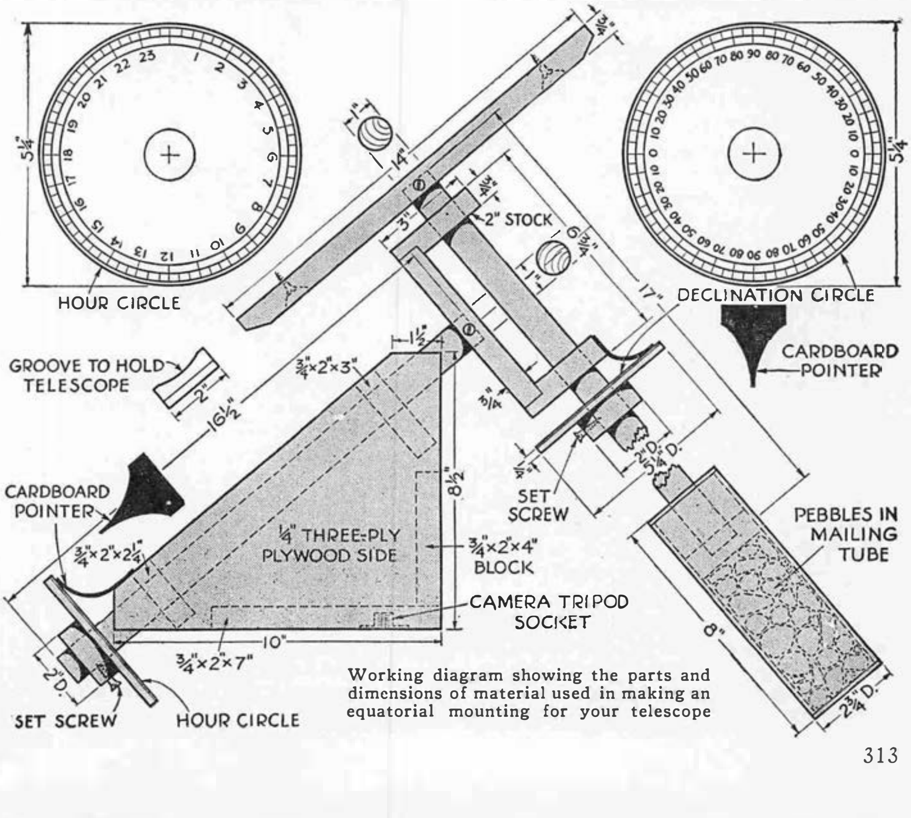
Declination and right ascension (often abbreviated to R. A.) can be illustrated simply in the following way:

Stand outdoors at night and turn your eyes upward toward the sky's equator, with your back to the polestar. Then turn your head from east to west. Your head is then working as an equatorial mounting for the binocular telescope of your eyes. As you turn your head from east to west it is turning upon the polar axis in your neck. And as you nod your head up and down, sweeping your eye-telescopes from zenith to horizon, your head is turning upon its declination axis.

With the scale plan shown and the pictures of the mounting in the illustrations, you can easily construct a practical equatorial mounting that will give good service with a light telescope. Note that the hour-circle pointer points to the meridian of the equator, and is fastened to the lower bearing of the polar axis. The declination pointer indicates the north pole of the heavens and is fastened to the bearing of the declination axis.

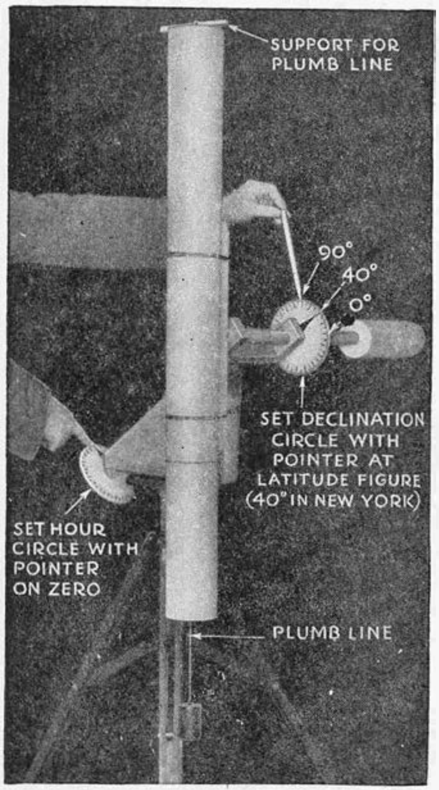
The telescope illustrated in the photographs was made with a portrait attachment lens for the object glass, and a folding pocket lens for an eyepiece. The portrait attachment lens has a focal length of thirty-six inches. The pocket lens has a focus of about six-tenths of an inch. By using a simple rule, we can now find the magnifying power of the telescope. The rule is: Divide the focal length of the object glass by the focal length of the eyepiece. The result will be the power of the complete instrument. The telescope therefore is of sixty power. It apparently brings the moon many times closer and plainly shows its craters.

If you wish to make a telescope giving you 120 magnifying power, secure from an optician a weak positive spectacle lens of six feet focal length to use for your object glass. Then make your telescope with an extended barrel, one that is long



Working diagram showing the parts and dimensions of material used in making an equatorial mounting for your telescope enough to correspond, and use a lens of six-tenths inch focus for the eyepiece.

Almost any small magnifying lens of short focus will do for your eyepiece. The small ones called "linen counters" are suitable. They are usually mounted in a folding brass frame for the pocket. You can take this frame apart or mount it entire upon the end of the inner sliding tube.


SUPPORT FOR PLUMB LINE
90°
40°
0°
SET DECLINATION CIRCLE WITH POINTER AT LATITUDE FIGURE (40° IN NEW YORK)
SET HOUR CIRCLE WITH POINTER ON ZERO
PLUMB LINE

This illustration shows how to adjust your equatorial telescope for use. Note that the object glass and the eyepiece are removed before declination axis and tube are adjusted

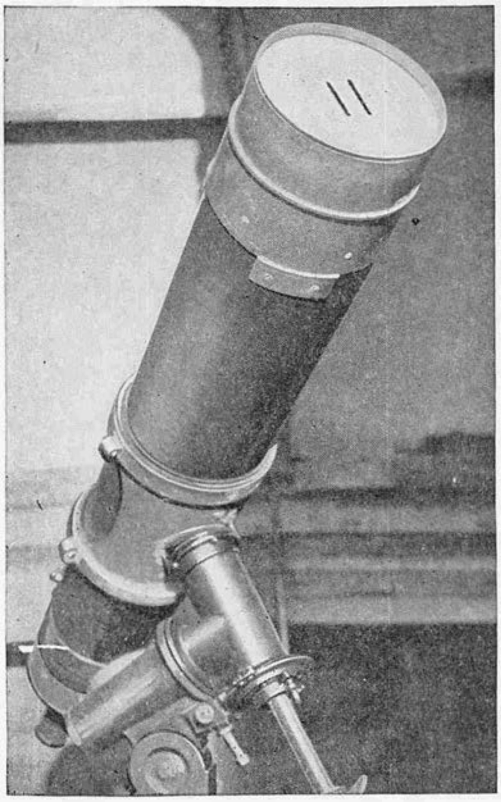
This telescope, made from two positive, or convex lenses, will give you an inverted image, as all astronomical telescopes do.

IN MAKING the telescope barrel, you will have to find materials to suit the lenses you are using. The original telescope shown in the photographs was made from a large cardboard mailing tube which happened to be of the correct length, thirty-six inches. It was lined with black paper to prevent stray light reflected from the inner surface from confusing the image. A slightly smaller mailing tube, about ten inches long, was made to slide inside the barrel. To this the eye-piece lens was attached. The arrangement is shown clearly in the photographs.

An excellent body tube for a homemade telescope can be obtained from newsprint paper cores. These can usually be obtained from large newspaper plants for little or nothing. The walls of the tube are about one-half inch thick, which makes them very strong. They can be made waterproof by wrapping them on the outside with a layer of linen tape, and then giving them two or three coats of paint.

The magnified image you will see through a homemade telescope of this kind will not be perfectly sharp, but it will be clearer the longer you make your telescope. In other words, the optical errors of a simple spectacle lens are less important when the lens is of six-foot focal length than with a three-foot lens.

HOW STAR MEASUREMENTS ARE MADE



A USEFUL device for demonstrating the principle of the stellar interferometer for measuring stars can be made by cutting two narrow parallel slits equidistant from the center of a cardboard disk, which is then placed over the lens of the telescope. If one of the brighter stars is viewed through this arrangement, the customary small, round star-image will be replaced by a series of images in the form of a narrow band.

In actual practice, with large and accurate instruments, the light from the star is reflected into the telescope by a system of movable mirrors that can be separated by as much as fifty feet, depending upon the size and distance of the star. If the star under observation is very large, the dark bands, or interference fringes, will disappear when the mirrors are moved a sufficient distance apart. Knowing this distance, the star's diameter can be computed.

While, of course, no star diameters can be actually measured with this simple device, it illustrates the methods by which it has been possible to measure many of the stars.

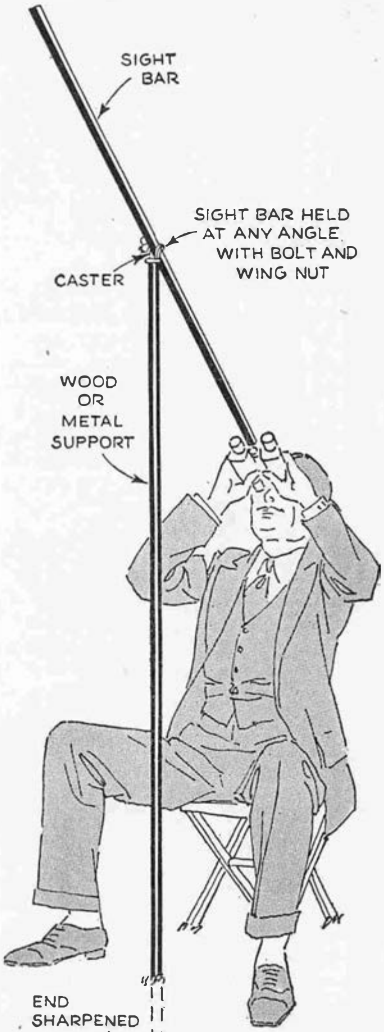
WOODEN STAR SIGHTER AIDS IN STUDYING ASTRONOMY

ONE of the biggest difficulties which crops up when sharing astronomical observations with another person is that of pointing out some particular star, faint planet, or any other inconspicuous object. A star sighter like the one at the right can be constructed in a few minutes from materials to be found almost anywhere, and will add greatly to one's pleasure in showing the different features of the heavens to others.

Take an ordinary chair or bed caster and file off the rivet that forms the axle for the wheel. Remove the roller, and in its place, mount a smooth, straight stick of wood 3 or 4 ft. long, as shown. Trim it to a snug fit between the prongs of the caster, drill a hole through it, and secure it with a bolt and wing nut. This forms the sight bar and swivel table.

The star sighter shown in the drawing is for outdoor use, so it is mounted on a 6-ft. length of 1 by 1-in. wood that has a hole drilled through one end to take the caster pin, and is sharpened at the other end for driving into the ground. An even better arrangement would make use of a length of metal tubing whose inside bore was of such diameter as to take the caster pin snugly. For use on a roof top or other solid place, it is easy to arrange a base for the upright.

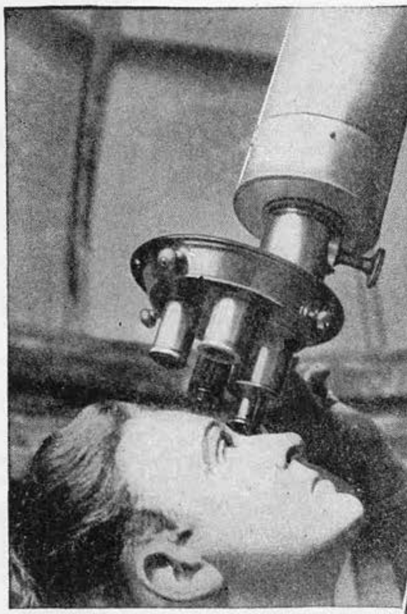
When a star is located, the observer sights along the bar and aligns it to point toward the star, then locks the wing nut. By sighting along the bar, the second observer has no difficulty in picking out the object, either with the naked eye or with binoculars. A device of this kind is splendid for amusing guests on summer evenings.



One observer sets the pointer; then others merely sight along it to locate the star

Eyepiece Turret *for* Amateur Telescope

FORMED FROM PIE PLATES

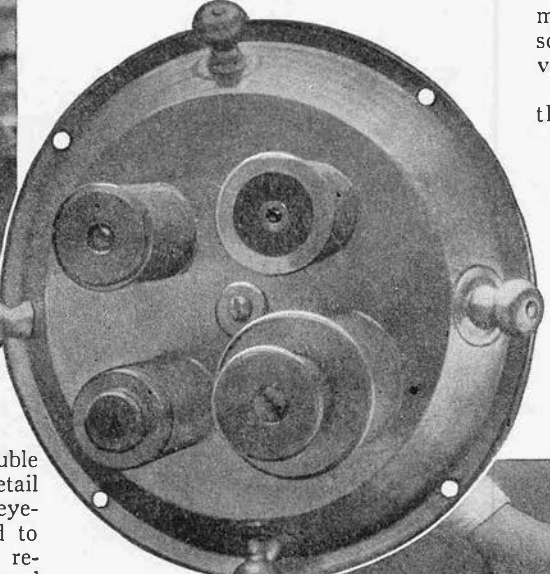


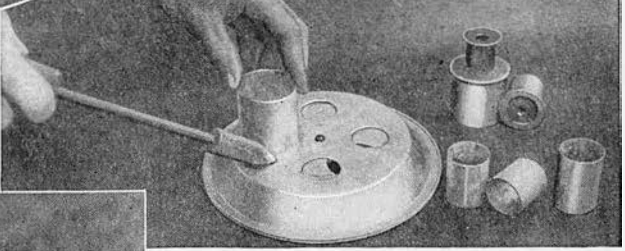
EVERY astronomer, whether amateur or professional, knows full well the inconvenience of having to change the eyepieces of the telescope whenever a different magnification is necessary to separate a double star or to reveal more clearly some detail on the moon or planets. A revolving eyepiece turret can easily be constructed to relieve the observer of the task of removing and inserting eyepieces and end the risk of breaking the lenses during the changing process.

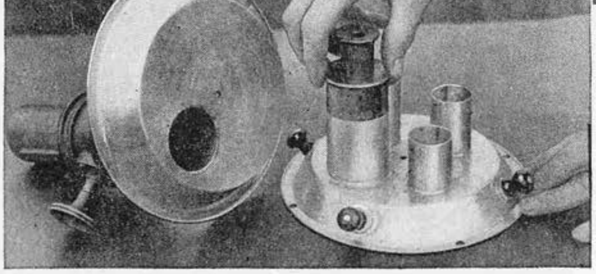
Many a lowly pyrex baking dish has been transformed into a telescope mirror, and now a second raid on the kitchenware solves the problem at the other end of the instrument, for the chief requirements for making such a turret as shown are two ordinary tin pie plates.

If three or four eyepieces are to be used, the plates should have a bottom diameter of about 6 in. Slightly bend the beading of one of the plates so that, when they are nested, the bottoms and sides will be in contact, leaving the edges slightly apart.

Nest the plates and drill a hole for a 3/16-in. stove bolt through both plates in the exact center. Cut another hole in the bottom of the inner plate just large enough to admit the end of the focusing tube of the telescope. This hole, as well as the ones to be cut for the various eyepieces, can be easily made by sharpening a screw driver with a narrow blade to serve as a chisel. First cut around the scribed circle, then smooth up the edges with a round file. Solder this plate directly to the telescope tube, using a try-square or straightedge to make sure that it is mounted accurately at right angles to the line of sight. In most cases it will be found best to pivot the turret directly above the telescope tube, as this prevents any interference with the pier or mounting when the instrument is pointed toward the zenith.







The eyepiece turret in use on a refracting telescope, a close-up of the device with the eyepieces in place, and views showing how it is assembled

Lay out and cut the holes for the eyepiece tubes in the other plate so that each one, when rotated, will line up with the large hole in the inner plate. The eyepiece tubes are made by rolling a piece of light-gage sheet metal over a piece of pipe to give it the required form, then using the eyepiece itself to get a good, close slip fit. The butt seam is soldered and dressed down with emery paper. The length of these tubes should be determined by the individual requirements of the observer, but each must be soldered to the plate as squarely and vertically as possible.

In order that the observer can tell in the dark just when the various eyepieces are in the proper position for use, a ¼-in. hole should be drilled in the rim of the inner plate diametrically opposite the large hole. Bolt the plates together and, when each eyepiece tube is in the observing position, drill a hole in the outer plate to coincide with the one in the inner plate. Thus, in actual practice, the night sky can be clearly seen through the upper holes when an eyepiece is in position.

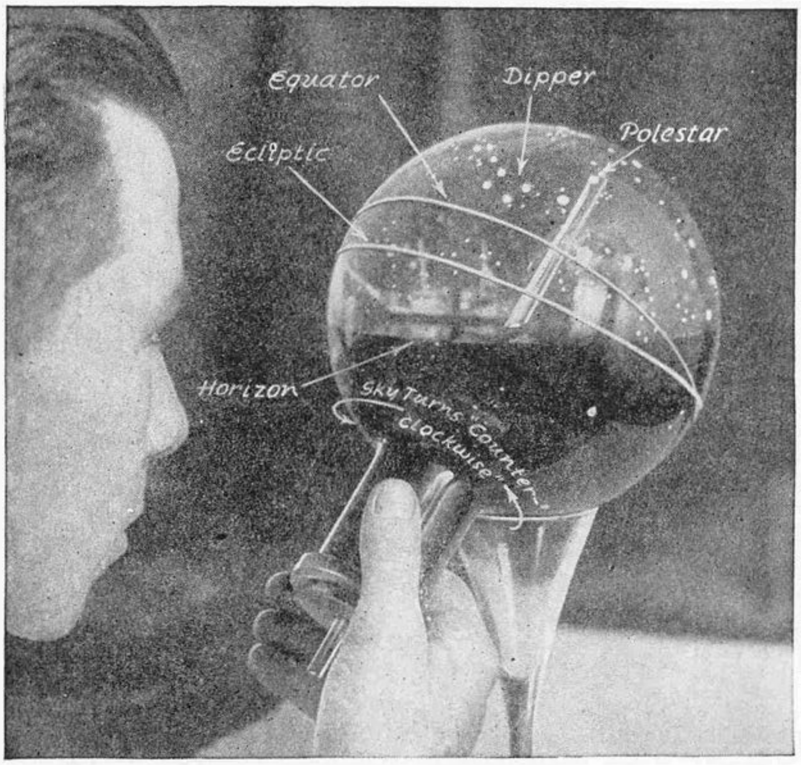
The four knobs by which the turret is rotated are simply pot-cover knobs that have the bolt cut off and soldered to the inside of the large tin washer furnished with them. The washer is then soldered to the side of the plate.

The center bolt should be provided with plain washers and double nuts so that it will not work loose. A thin film of oil or grease should be applied to the surfaces that are in contact. The outside may be finished as desired. Brass or gold bronze give an attractive and professional appearance.

This device is perfectly adaptable to eyepieces of every description as, for example, the large comet-seeker eyepiece shown in the illustration; and, though used here on a refractor, it will function equally well when mounted on a telescope of the reflecting type.

Homemade Planetarium

Many Interesting Experiments, Laws, Can Be Performed with



A chemist's flask, half filled with inky water and painted with stars according to the diagram below, makes a miniature planetarium. Rubber bands represent the equator and ecliptic, and a wineglass makes a support for rotating the flask

STARS move across the heavens, the moon passes through its phases, and the sun rises and sets in pictorial grandeur in a big planetarium. At present only two cities in America, Chicago, and Philadelphia, have these mechanical "universes" in which the movements of celestial bodies can be seen with almost startling fidelity.

Fortunately, however, even if you live far from Chicago or Philadelphia, you need not wholly deprive yourself of the thrills accompanying a demonstration in a planetarium. Many of the astronomical events to be seen in a big planetarium can be duplicated, on a small scale, in your own home with common materials and at slight expense.

The essential articles are a round-bottomed, spherical chemist's flask, several inches in diameter, and a glass rod fitting tightly into a perforated rubber stopper. This rod should reach exactly the bottom of the flask when it is corked tightly. All these essentials can be purchased for less than a dollar.

In order to add to the realism of the ocean horizon, secure a tiny celluloid boat and float it upon the surface of the ink-stained water before introducing the glass rod and the rubber cork into the flask. The little steamer helps you to imagine yourself at the center of the ocean, out of sight of land, with the sky and sea meeting at the circle of the horizon, where ink and glass meet.

When the stars of the entire celestial sphere have been indicated upon the flask, with dots of white paint, we are ready to duplicate many of the effects visible to the audience under the sixty-foot dome of a big planetarium lecture hall.

The stars whose positions are indicated on your flask are supposed to be viewed by people on the miniature ship, inside the flask. But as we cannot get into the bottle, the best we can do is to look through the bottle at the stars painted upon the opposite side. Accordingly, the star group figures which you paint upon the outside are reversed, because intended to be viewed from the inside.

The first step to be taken in preparing the flask is to place in position two rubber bands of different colors. Let a red band placed around the exact middle of the flask stand for the sky's equator. Then let a gray rubber band, set at an angle of about twenty-three degrees to the other, stand for the ecliptic, or path of the planets, moon, and sun.

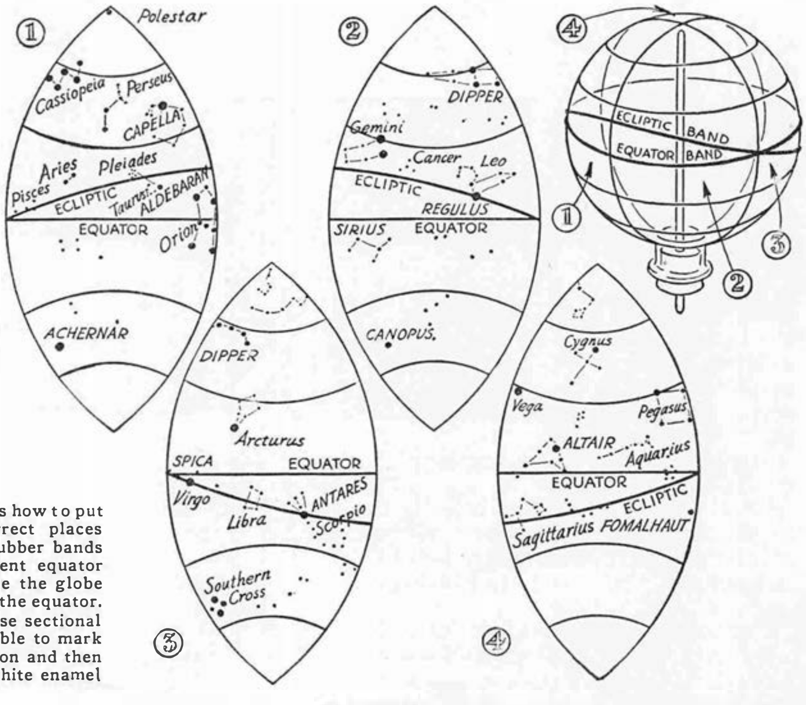
The second step is to divide the distances from equator to poles into equal thirds. This is easily done with a measuring tape or strip of paper. Each third stands for thirty degrees, and the whole quarter-circle for ninety degrees. The divisions are marked upon the glass with a greasy crayon or china-marking pencil, and a circle is drawn through each division. Each circle extends entirely around the flask, and is parallel to the equator band.

With these greasy-crayon lines and the quarter-sphere maps below as guides, it is easy to add the stars with a small brush and dots of white paint or enamel.

When the paint is thoroughly dry, with the flask filled half full of inky water and tightly corked, your parlor planetarium is ready for use. Rest it upon a wine glass, with the glass rod meeting the ink at an angle equal to your latitude. (In New York this is about forty degrees.)

Take hold of the neck of the flask and turn it slowly in a counterclockwise direction.

As you look through the near side of the flask,

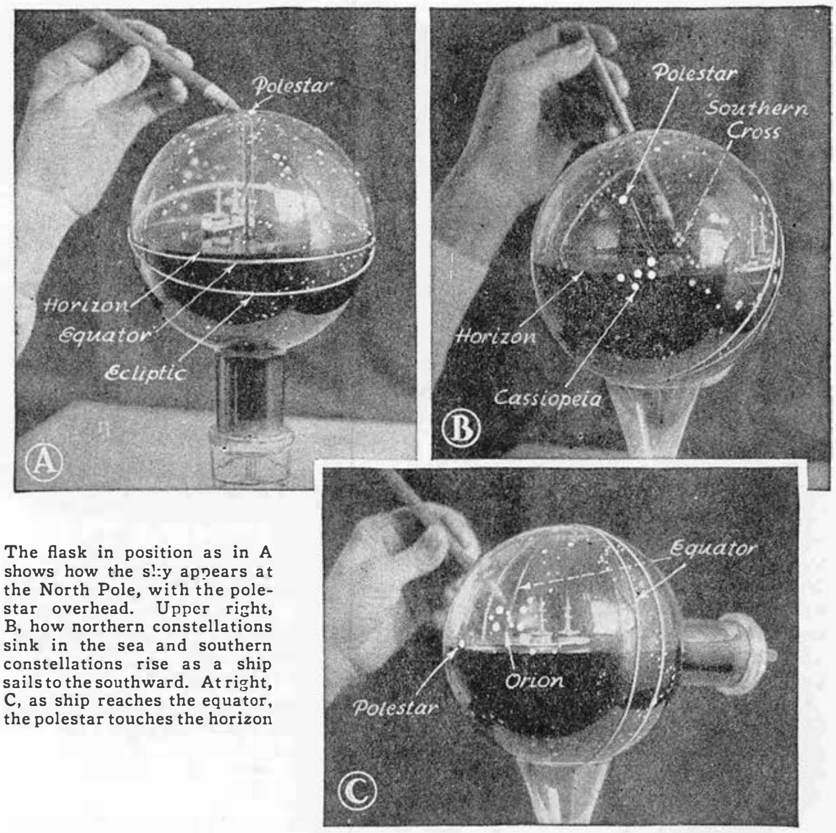


This diagram shows how to put stars in their correct places on the flask. Fix rubber bands in place to represent equator and ecliptic. Divide the globe into quarters along the equator. With the aid of these sectional maps you will be able to mark positions with crayon and then dot them in with white enamel

for Amateur Astronomer

Demonstrating Astronomical

this Simple Model Easily Made



The flask in position as in A shows how the sky appears at the North Pole, with the polestar overhead. Upper right, B, how northern constellations sink in the sea and southern constellations rise as a ship sails to the southward. At right, C, as ship reaches the equator, the polestar touches the horizon

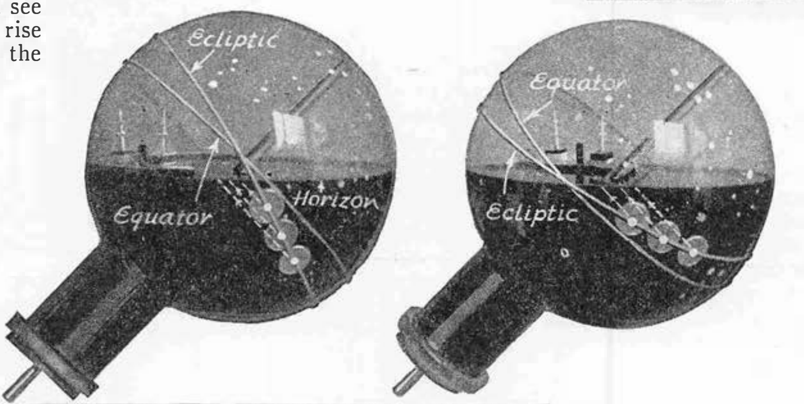
you see some of the stars upon the far side rise over the ocean horizon, cross the sky and set in the sea at the left. Other stars (circumpolar stars) simply go round and round the upper end of the slanting glass rod which represents the axis of the celestial globe. These stars never set. Other stars, seen near the neck of the flask, below the surface of the ink, never rise in northern latitudes.

Now let us go on a trip from pole to pole in our table-top planetarium, just as the audiences do at a planetarium show.

To go northward from our latitude, we simply lower the neck of the flask gradually. You will have to take the apparatus off the wineglass support and hold it in your hand. As the neck is lowered, the glass rod representing the polar axis of the sky rises. When it is vertical, rotate the flask slowly between your hands and you will see the sky as it would appear if you stood at the North Pole.

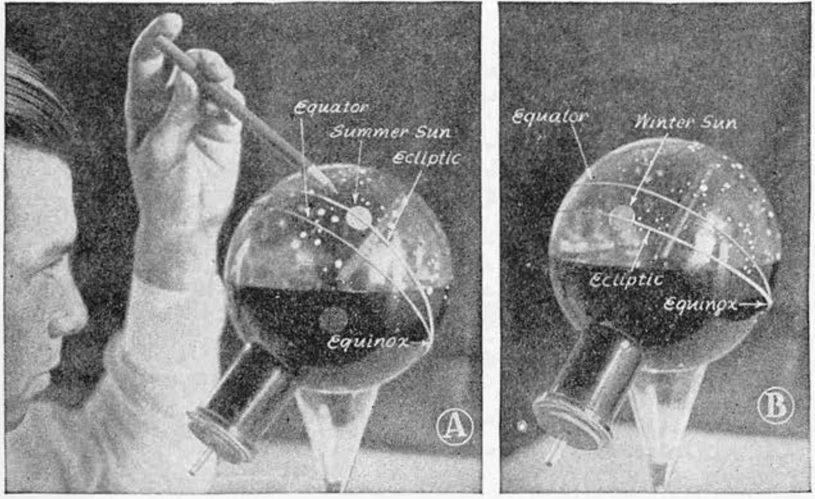
Straight overhead is the Polestar and around it the entire heavens revolve. The constellation Orion will be always on the horizon, for the horizon is always parallel to the sky's equator.

Slip a ten-cent piece under the rubber band representing the ecliptic, at a point below the equator band and rotate the flask as before. You will see why the sun does not rise above the horizon during the six months it is passing over the half of its path which is always below the horizon at the North Pole.



In the left-hand picture, dimes under the ecliptic band show three daily positions of the moon in spring. At the right, the positions in autumn explain how the "Harvest Moon" is caused

Slip the ten cent piece along under the ecliptic band to the other side of the flask, where the band rises above the equator band. When the flask is rotated, you will experience the midnight sun, when the luminary never goes below the horizon for the six-months'-long summer day.



Changes of the seasons are explained by this simple experiment. A dime placed under band, A, representing the ecliptic, above the line of the earth's equator, shows the position of the sun in summer; at right, B, below the equator, the sun's winter course

Now tip the flask back, replace it upon its wine glass support, and continue raising the neck. When the glass rod is level with the surface of the ink, the position of the stars represents what we would see when our ship reached the equator. The polestar is on the northern horizon, and, if it is winter, Orion will pass through the zenith over our heads.

If you continue tipping the flask until the glass rod is again vertical, you will view the stars as they are seen in Little America, and as South Pole discoverers saw them. Orion, the equatorial constellation, is now standing upside down, upon the northern horizon. In fact, all the northern constellations visible south of the equator are standing upon their heads. Another odd point is that the midday sun slants down from the north instead of from the south. In a hotel in Argentina, you would ask for a room with a sunny northern exposure! Your parlor planetarium makes it easy for you to demonstrate this with the dime that represents the sun slipped under the rubber band that stands for the ecliptic.

The dime also enables you to demonstrate beautifully how the sun in our northern latitudes rises north of east during summer, south of east during winter, and straight in the east at the spring and autumn equinoxes.

To demonstrate these points, place a dime at the points where the ecliptic and equator band cross. If the flask is rotated around its glass rod axis after each shift of the coin, the rising points can be noted.

WHILE doing this it is also fun to measure from horizon-rising points to horizon-setting points along the ecliptic band. The distance which the dime is above the horizon will be found considerably longer and shorter respectively in summer and winter. With the dime at the equinoxes, however, the tape will measure just half the circumference of the flask from horizon to horizon in either direction. In other words, day and night (nox) are equal (equi) at the equinoxes.

An interesting variation of this experiment is to consider the dime as the silver moon and place a copper cent for the red sun. The sun should be placed under the ecliptic band just opposite the moon. We can then demonstrate that when the summer sun is high in the sky, the summer moon is running low. Also, when the winter moon rides high, the weakened sun travels low across the southern sky.

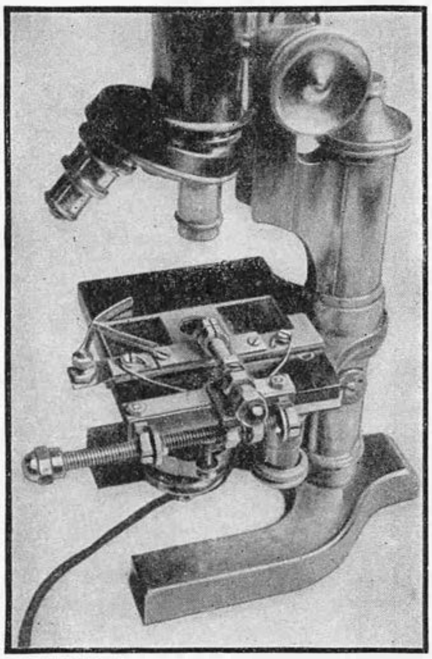
Finally, let us try an experiment with three dimes at the three successive positions of the moon during its monthly progress around the earth. When placed under one part of the ecliptic band, the dimes arrive on successive days at the horizon with the ecliptic at a very sharp high angle with it. This occurs in spring and results in long intervals between one time of full moonrise and the next. The delay in moonrise caused in this way may be as much as an hour.

BUT when the three dimes are shifted to a part of the ecliptic band which is at a low angle with the horizon, the delays between successive moonrises are much less. This condition occurs in autumn, and results in the short intervals between times of full moonrise which are called "Harvest Moon" in September and "Hunter's Moon" in October.

The experiments outlined in this article by no means exhaust the possibilities of the parlor planetarium. It is a fascinating toy to have around for continued experiment. It has, in fact, been suggested that (with a suitable decorative base) a parlor planetarium might be an interesting permanent mantel or table ornament.

Mechanical Stage *for* MICROSCOPE

Has four-way movement

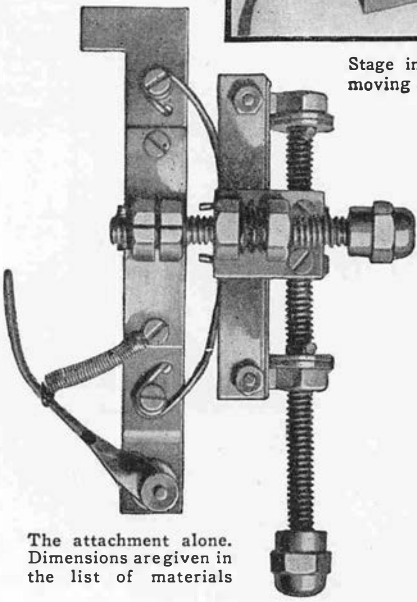

Stage in place on microscope for moving slide in systematic manner

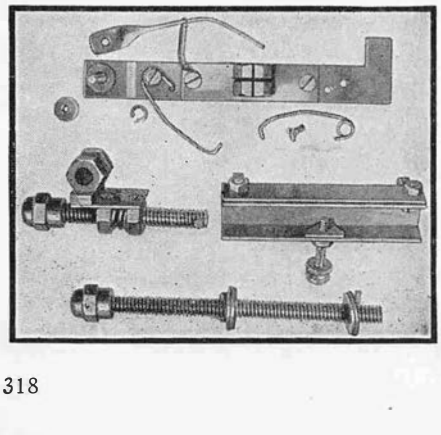
A MECHANICAL stage is a useful accessory to move slides very slowly across a microscope stage and to enable the worker to examine his slides in a systematic manner. Microscopists will recognize the advantage of this simple device when they wish to refer to a certain part of a slide at various intervals. If a scale is etched on top of the stage, the stage can be reset by this for any future reference to a particular spot on the slide.

The mechanical principle used to obtain the four-way movement is not complicated, yet it gives smooth movement in four directions.

The accessory is constructed of standard brass stock, machine screws, and nuts. Brass is suggested because of the ease with which it can be drilled and cut, and the additional advantage that it makes a good-looking job. The end nuts on the slide holder supporting the long propelling machine screws have the threads drilled out to act as bearings. Note that these nuts are sawed open in order that they may be clamped tightly around the machine screws to make the bearings free from play. Springs are put between the two sets of nuts on the moving platform to take up play, there being just enough force exerted to press the nuts apart. If screws with forty or more threads to the inch are used, the springs will not be necessary. Two safety pins are used as springs to make the slide holder more rigid. It will be noted that these springs fit between two guide pieces of thin brass, one being on each side of the channel and overlapping it slightly. All the nuts are drilled and tapped, and fastened in place with No. 4-36 machine screws, which are cut off flush with the nuts. All parts must fit closely, but not too tightly. It is important to avoid any unnecessary backlash.

When all the brass parts are cut, drilled, tapped, and ready for final assembly, it is suggested that they be cleaned with emery and polishing cloth. Another refinement is to scribe a scale of numbers on a convenient place on the instrument to enable the worker to make a record of various sections of the slide for future reference.


The attachment alone. Dimensions are given in the list of materials

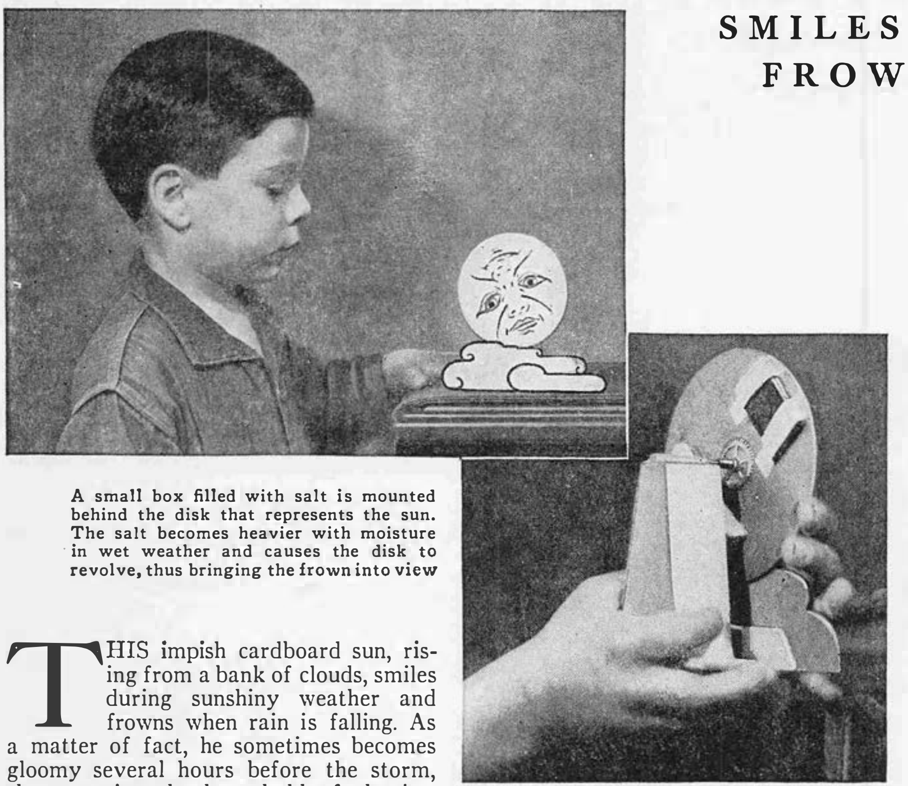

Parts ready for assembly. The ends of the two bent springs work in a groove formed by slightly projecting strips of brass clamped above and below the top part of the channel

List of Materials

1—¼-in. running thread (or machine screw) 4 in. long and 1—3-in. long. (Use 40 threads to the inch if obtainable.)
10—¼-in. nuts.
2—¼-in. washers (brass and felt combination).
2—¼-in. compression springs, ½ in. long (if necessary).
2 safety pins.
12—No. 4-36 machine screws, ½ in. long.
1 piece of channel brass No. 18 (or bend stock to fit), 3 in. long.
2 pieces of strip brass 3 in. long, for guides for safety-pin springs.
1 piece of thin brass for the spring slide clip.
2 end nuts (acorn nuts).
1 piece of brass, 6 in. long, for slide holder.
Tools required: small vise, hack saw with fine blade, small hand drill, No. 4-36 tap and drill, drill for making hole through which No. 4-36 screws will slip, ¼-in. drill for drilling threads out of bearing nuts, small file, center punch, and screw driver.

Homemade Weather Guide

SMILES IN SUNSHINE, FROWNS IN STORM



A small box filled with salt is mounted behind the disk that represents the sun. The salt becomes heavier with moisture in wet weather and causes the disk to revolve, thus bringing the frown into view

THIS impish cardboard sun, rising from a bank of clouds, smiles during sunshiny weather and frowns when rain is falling. As a matter of fact, he sometimes becomes gloomy several hours before the storm, thus warning the household of the impending downpour. He can be built in one evening from cardboard and other odds and ends costing not more than five cents.

Prepare paper patterns of the sun, which is 4 in. in diameter, and of the two clouds by sketching them through 1-in. squares, as in the accompanying drawing. Rub the backs of the patterns with soft lead pencil to blacken them, and trace onto white cardboard, or use ordinary carbon paper, if you prefer. Then go over the lines of the face with India ink. Care must be taken not to emphasize the mouths too much, as they represent forehead lines also, and if they are too strong, both faces will be equally prominent, instead of the one right-side up being the more noticeable. Draw the clouds as boldly and modernistically as you please and cut them out, afterward blackening the edges, and paste the small cloud in front of the larger one.

Use a waterproof glue to paste the cloud assembly to the upturned flap of the base piece, as shown in the perspective drawing. Before attempting to fold the cardboard, score the line with a dull knife, and no trouble will be experienced. Fold the main support or standard from a strip of cardboard cut 1¼ by 8½ in. Paste the feet to the base, where they can be held with clothespins. To stiffen this unit, trace pieces to fit between, and glue them flush with the edges.

A wheel salvaged from a junked alarm clock serves as a bearing. The kind needed is the gear with the sleeve bearing that is mounted on the hand spindle. It is of such bore that it will fit loosely on a sixpenny finish nail used for a shaft, but the wheel end must be reamed out with a drill to receive the head of the nail. Of course, the head can be filed down easily if the drill at hand is not the right size. Keep the fit loose, for the bearing must work freely. Glue the gear to the back of the disk at the center, first inserting the nail, and twist the latter with the fingers to be sure the glue does not adhere to it. The inclosed head prevents end play of the bearing on the shaft.

Now prepare the sensitive element. Obtain a small cardboard pill box, remove the cover, and fill with ordinary untreated salt—the kind sold in cloth bags, which commonly becomes caked in salt shakers if there is the slightest moisture in the air. Lay a piece of coarsely woven cloth over the top and paste down the edges on the sides, for the purpose of holding the salt in but allowing free access of the air. Paste the box to the disk behind the mouth of the frowning face and as far from the center as possible.

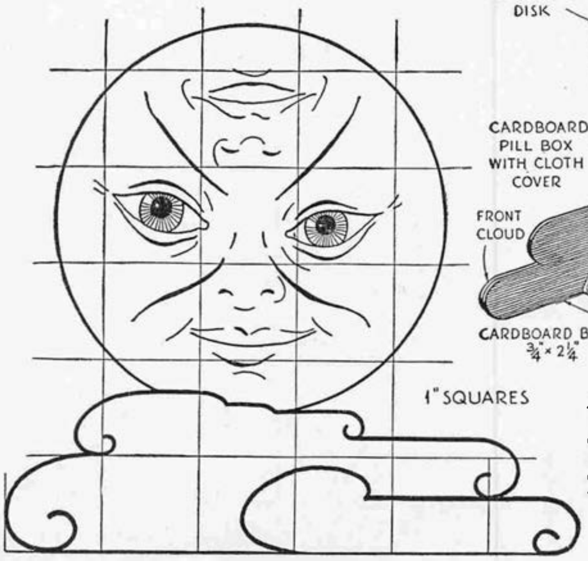
Counterbalance the salt with metal plates or nails, glued to the disk diametrically opposite. Add just enough weight to overbalance the face when the weather is fine—the bearing having been lubricated with sewing-machine oil.

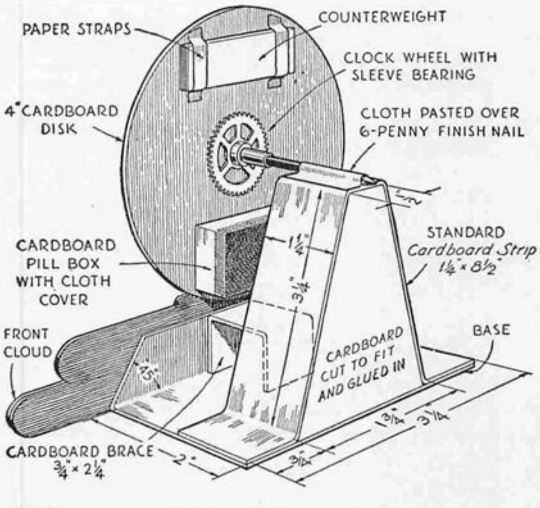
If good weather is not at hand, dry the gadget well in a warm oven. On the other hand, to manufacture rainy weather, close the device up in a small box that has been drenched with water inside and has a can of water inside as well. If you have been careful with the bearing and if the counterweight was just sufficient to bring up the smiling face in the warm oven, incarceration in the damp box should turn the sour face right-side up.

The final step is to mount the shaft on the upright and secure it by gluing a piece of cloth over it. The clearance between face and cloud should be about 1/16 in.

The appearance of the midget weather prophet is improved by tinting the lips, cheeks, and cloud edges with a little water color. Waterproof the cardboard with a coat of white shellac or clear lacquer, and set it in an open window where the outside air can reach it.

If the bearing sticks now and then, jar it by tapping the standard with the finger.

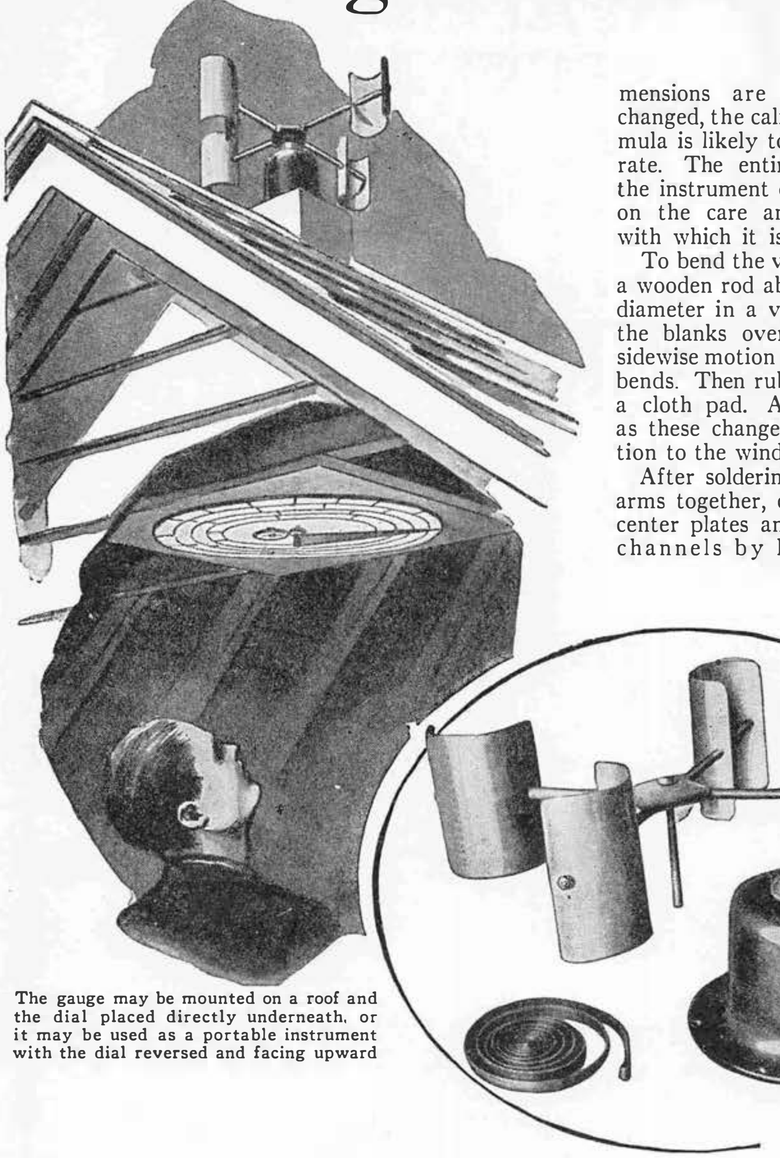



PAPER STRAPS
COUNTERWEIGHT
CLOCK WHEEL WITH SLEEVE BEARING
4" CARDBOARD DISK
CLOTH PASTED OVER 6-PENNY FINISH NAIL
STANDARD Cardboard Strip 1¼" × 8½"
CARDBOARD PILL BOX WITH CLOTH COVER
1¼"
3¼"
FRONT CLOUD
BASE
CARDBOARD CUT TO FIT AND GLUED IN
45°
CARDBOARD BRACE ¾" × 2¼"
2"
3½"
1¾"
3¼"

A rear view showing the method of mounting the disk on a well-braced cardboard support. The base piece is turned up in front so that the cardboard clouds can be fastened to it. Patterns are given at left

Making a WIND GAUGE

A highly simplified anemometer in which the vanes do not spin, but turn against the torsion of a spring



The gauge may be mounted on a roof and the dial placed directly underneath, or it may be used as a portable instrument with the dial reversed and facing upward

Assembled vanes, the horn-motor cover that serves as a support, and the clock spring, which is set inside the housing

A 231-MILE wind tore at the Mt. Washington, N. H., meteorological station not long ago. The pressure on the cabin must have been more than 240 lb. per square foot, and the force against a section of wall 8 by 10 ft. at least 9½ tons!

It is always interesting to speculate on the velocity of the wind, whether a gentle breath that ripples the water and makes the leaves dance, or a rending gale that lifts roofs and rips branches from the trees. From odds and ends you can build an anemometer that will indicate this velocity, provided it is properly calibrated, more accurately than the speedometer on your automobile usually registers your driving speed.

This meter does not spin continuously, but is of the direct-reading pressure type, with cup vanes that revolve in the wind against the torsion of a spring until the two forces balance. The drawings show the construction clearly, but a few points must be especially noted. It should be remembered that each anemometer has its special characteristics, so that if any dimensions are materially changed, the calibration formula is likely to be inaccurate. The entire value of the instrument depends upon the care and accuracy with which it is calibrated.

To bend the vanes, clamp a wooden rod about 2 in. in diameter in a vise and rub the blanks over it with a sidewise motion to start the bends. Then rub them with a cloth pad. Avoid kinks, as these change their reaction to the wind.

After soldering the cross arms together, cut the two center plates and form the channels by laying the plates on a pine block and hammering with a rounded cold chisel. When the two are done, bolt them to the arms and solder solidly.

Now drill for the spindle, solder it in, and solder the cups on. Balance the assembly by driving solder into the light ends of the arm tubes.

The spindle bearing is a skate wheel which costs about 15 cents at a hardware store. Select one with a minimum of side play.

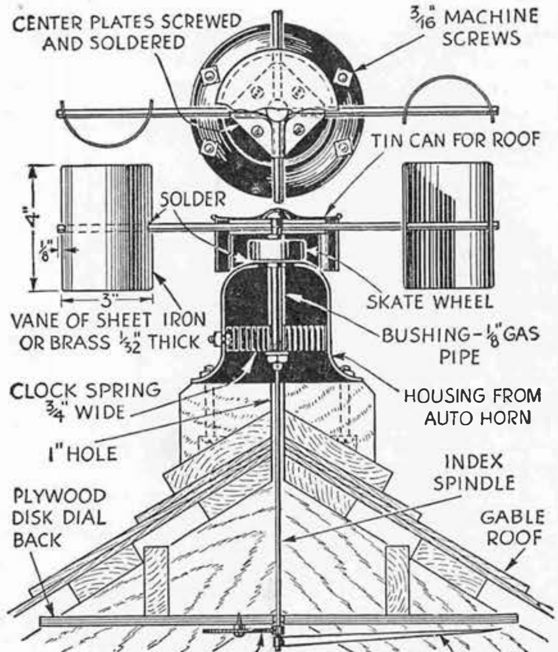
From an automobile wrecking yard obtain a horn-motor cover having a flange so that it can be bolted directly to the base. Chop a hole in the top with a cold chisel and solder the skate wheel over it as shown below.

The clock spring must be at least ¾ in. wide. If very high velocities are common, two, three, or four springs will have to be ganged together. The cross arms then should be made of heavier material to resist the strain. This, of course, cuts out the lower velocities, since the points on the dial will be so close together that they cannot be read; yet, even so, it is likely that breezes of five miles would be indicated.

Break off enough of the spring that it can be entered in the housing without rubbing much on itself. Punch a hole in the outer end, and drill one in the housing to receive a bolt.

Set the spindle in the bearing, slip on the bushing, install the spring and washer, and tighten the nut, burring the end of the spindle to prevent loosening. Drill a ⅛-in. hole for

The drawings below show a side view of the complete installation and a broken-away top view of arms, vanes, and housing



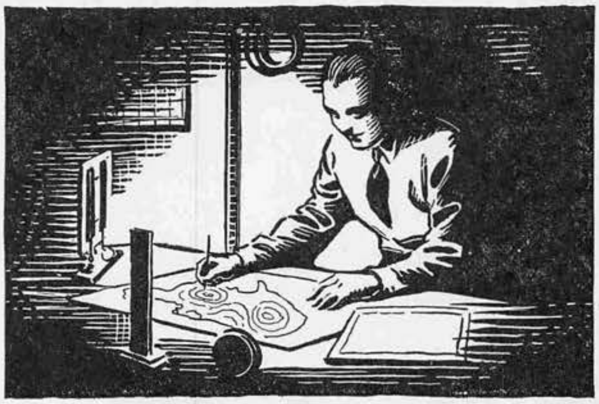
the index-hand spindle. Solder on the tin-can roof.

The instrument is now ready for calibrating. Solder a stiff wire to the edge of one vane to act as a pointer, and stand the apparatus on a piece of paper on a table in a room free from drafts, so that the zero point can is located. Mark this with a pencil. Now tie a string loop to the hook of light spring scales, slip the loop under a vane, adjust the scales to pull at right angles to the center, and draw the arm around until the reading is ½ oz. Take a similar reading at 1, 1½, and 2 oz. Now check these readings with each other, and if the marks on the dial are not equidistant, take new readings. The scales must be at right angles to the vanes.

If suitable scales are not available, you may make a substitute by tacking a rubber band to a strip of wood. Tie a loop of string to the free end of the rubber, load it with a ½-oz. weight, and mark the position of the knot on the wood. Do the same for 1, 1½, and 2 oz. Then use this device for calibrating the anemometer as shown in the photograph at the bottom of this page.

Dismount the anemometer and draw four circles as shown. Four are necessary because the vanes, when registering up to 45 M.P.H., sweep four times around the dial. The division points may be calculated according to this formula, which is much easier to work out than may appear at first glance: $d=DAV^2/2011.35$, where "d" stands for degrees, "D" represents degrees deflection obtained with a pull of 1 oz., "A" is the average area of the vanes, and "V" is an assumed velocity.

To illustrate: The length and breadth (diameter) of all vanes, multiplied together, added, then divided by four to get the average=12.19=A. Deflection in degrees with 1 oz. pull=101.25=D. Assume a wind velocity, say 23 M.P.H. Then $d=101.25\times 12.19\times 23\times 23\div 2011.35=324.6$ degrees.



SET UP A LITTLE

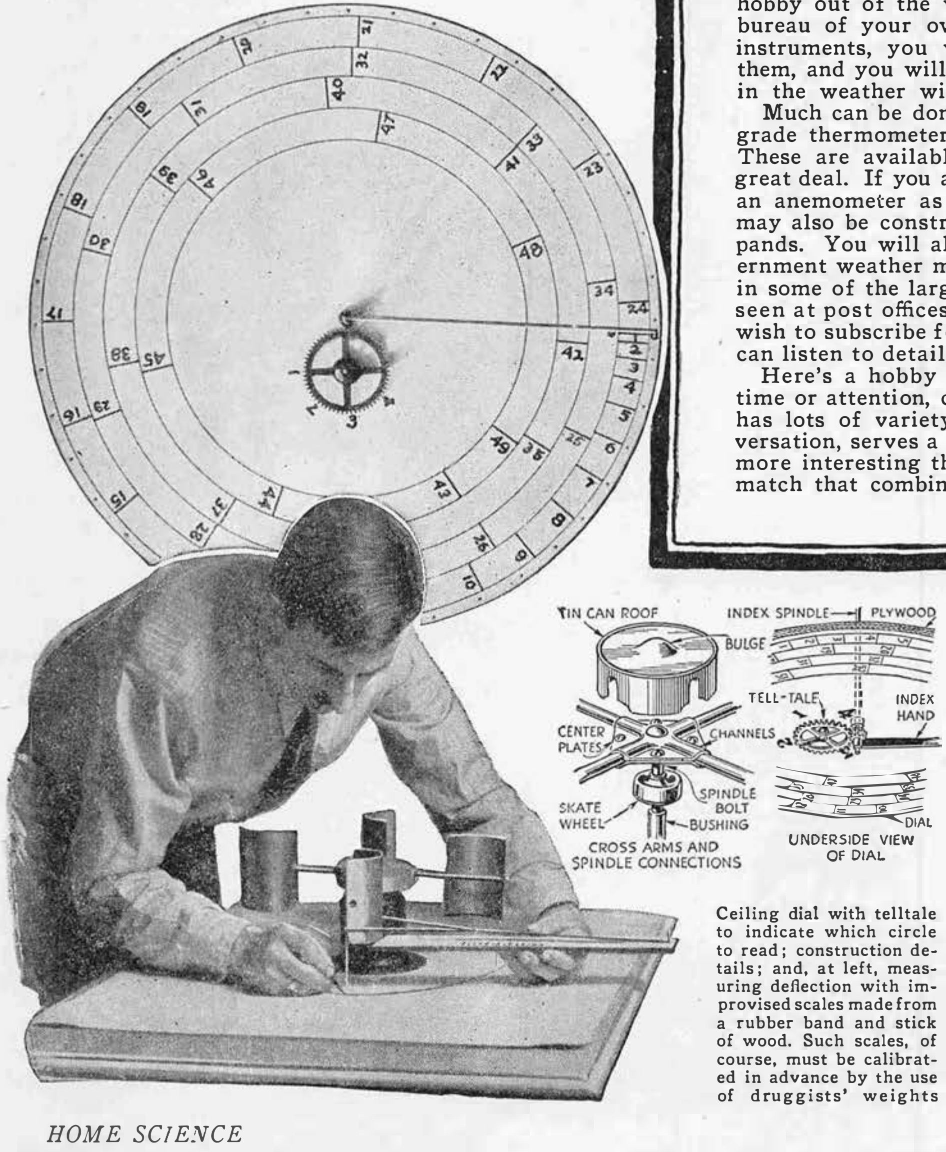
WEATHER BUREAU

OF YOUR OWN

WEATHER is the one great universal topic of conversation. Is it going to snow? Will it get warmer? Is a storm blowing up? Will there be a heavy frost tonight? You are always asking these and countless other questions, and talking about them to your friends. Why not make a real hobby out of the weather and start a little weather bureau of your own? As soon as you have a few instruments, you will find it fascinating to watch them, and you will quickly learn to forecast changes in the weather with surprising accuracy.

Much can be done with three instruments—a high-grade thermometer, a barometer, and a hygrometer. These are available everywhere and do not cost a great deal. If you are handy with tools, you can make an anemometer as described, and other instruments may also be constructed as your weather bureau expands. You will also need to consult the daily government weather map. It is now published regularly in some of the larger newspapers and usually can be seen at post offices or public libraries if you do not wish to subscribe for it yourself. And, of course, you can listen to detailed weather reports over the radio.

Here's a hobby for you! It does not take much time or attention, costs little, requires no great skill, has lots of variety, forms a good subject for conversation, serves a useful purpose, and grows steadily more interesting through the years. Where can you match that combination?



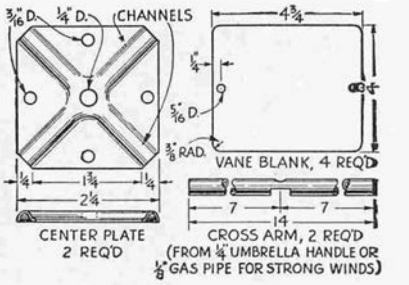
Ceiling dial with telltale to indicate which circle to read; construction details; and, at left, measuring deflection with improvised scales made from a rubber band and stick of wood. Such scales, of course, must be calibrated in advance by the use of druggists' weights

It is unnecessary to do all this multiplication every time a point is calculated. DA/2011.35 occurs every time; therefore obtain this amount and multiply the V^2 by it. Again illustrating, with my anemometer, $101.25\times 12.19\div 2011.35=0.614$, and the formula becomes $d=0.614\ V^2$.

A table of squares is appended, which will save the trouble of squaring V.

If you have a slide rule, set 1 on scale C over DA/2011.35 on scale D, with the rider glass over V^2 on scale C, and read the deflection beneath on scale D. After this, to read off a new deflection, it is necessary only to slide the rider to a new V^2 on C, and read from D.

Use a protractor to locate the points on the dial. When the four revolutions have been calibrated, lay the trial dial over a suitable piece of cardboard and transfer the points and circle center by pricking through with a needle. Then ink in the circles and divisions on the cardboard, cut out the dial, and mount it on a plywood base, fitting it for installation.



A pattern for cutting the four vane blanks, the arms, and the plates that hold them rigid

If the anemometer is to be portable, screw the housing directly to the dial, and leave the wire index hand in place. It can then be set in any desired place to test the wind, and can be used to calculate the flow of air in ventilating ducts or between buildings. If the wind is steady, the hand will practically come to rest over the mark showing the velocity; but if gusty, the vanes will oscillate and the average of the swing will be read.

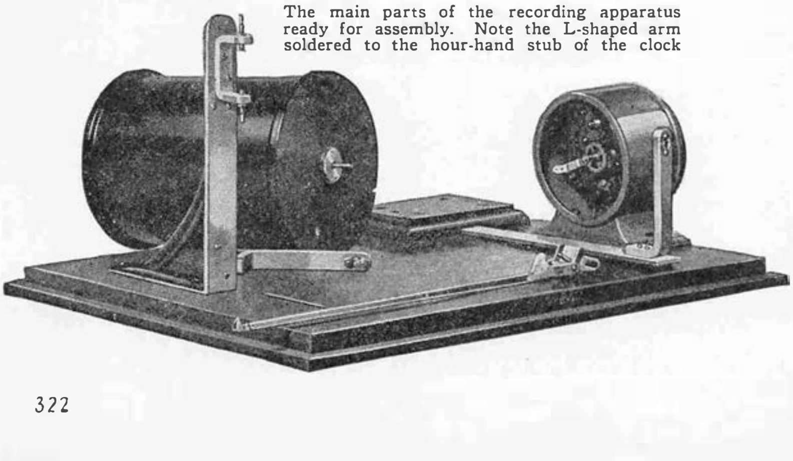
To mount the anemometer on a building, such as the garage, bolt the housing to a suitable block to straddle the ridge boards or to level it on the slope of a shed roof. Bore a 1-in. hole through the roof for the index spindle, and, before mounting the instrument, solder this spindle in the end of the bolt spindle. Thrust it through the hole, smear the underside of the block with roofing tar, nail it securely, and coat the outside with tar. Put a temporary shed or cover over the instrument to shield it from the wind until the dial is set.

Mount the dial upside down under the roof or ceiling. For this use, of course, it must be calibrated in the opposite direction to one used for a portable instrument. Since the vanes are free to swing through more than one revolution, a telltale is needed to show what circle is to be read. This consists of two clock wheels. A small pinion, drilled to fit the index spindle, is pushed up close to the dial and soldered. The large gear is mounted on the dial in mesh with the other by driving a nail through the center, and a hand is painted on one spoke. Mark the dial "1" to correspond, count around as many teeth as there are teeth on the pinion, and mark "2." Likewise locate "3" and "4."

The hand may be soldered or screwed in place on the index spindle, or attached by any other convenient method that will hold it securely.

Table of Squares

V	V^2	V	V^2	V	V^2	V	V^2
1—	1	20—	400	39—	1521	58—	3364
2—	4	21—	441	40—	1600	59—	3481
3—	9	22—	484	41—	1681	60—	3600
4—	16	23—	529	42—	1764	61—	3721
5—	25	24—	576	43—	1849	62—	3844
6—	36	25—	625	44—	1936	63—	3969
7—	49	26—	676	45—	2025	64—	4096
8—	64	27—	729	46—	2116	65—	4225
9—	81	28—	784	47—	2209	66—	4356
10—	100	29—	841	48—	2304	67—	4489
11—	121	30—	900	49—	2401	68—	4624
12—	144	31—	961	50—	2500	69—	4761
13—	169	32—	1024	51—	2061	70—	4900
14—	196	33—	1089	52—	2704	71—	5041
15—	225	34—	1156	53—	2809	72—	5184
16—	256	35—	1225	54—	2916	73—	5329
17—	289	36—	1296	55—	3025	74—	5476
18—	324	37—	1369	56—	3136	75—	5625
19—	361	38—	1444	57—	3249		



The main parts of the recording apparatus ready for assembly. Note the L-shaped arm soldered to the hour-hand stub of the clock

Recording

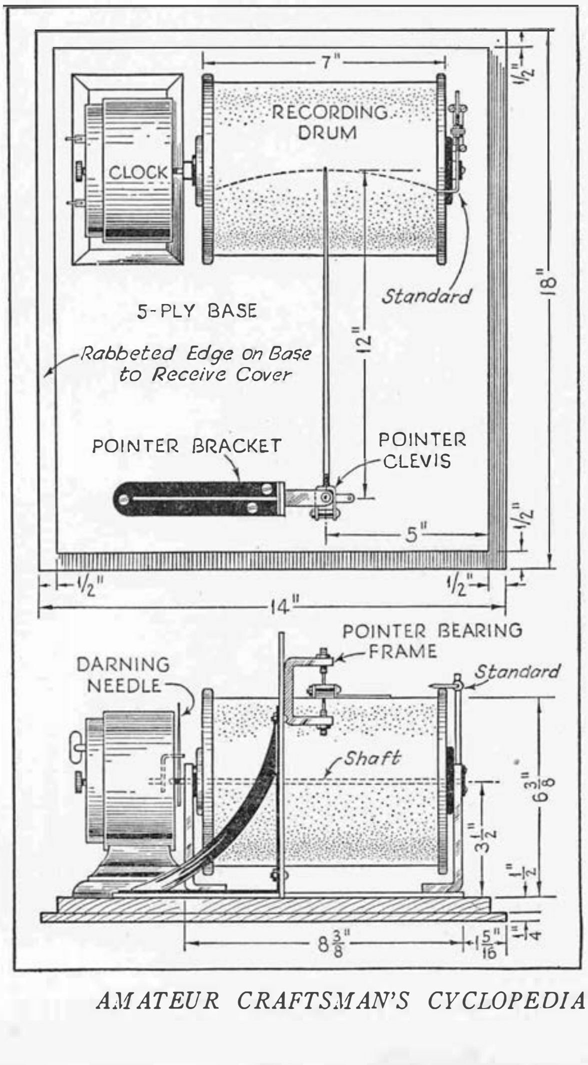
According to the old adage, a watched kettle never boils. On the other hand, an unwatched kettle not only boils, but generally foams over and often spoils the cooking. In the same way the amateur weather observer often finds that his anemometer is becalmed and registers zero during his leisure hours, when observation is possible, and cavorts in entertaining gales during working or sleeping time. Consequently a recording drum is desirable, as it not only charts the behavior of the wind continuously over a period of hours, but offers a means of comparing records from day to day and year to year.

The recording apparatus illustrated was designed for the anemometer which has just been described. Once the principle of construction is understood, any reasonably ingenious mechanic can adapt the design to suit almost any type of meteorological or other apparatus he wishes to equip with a recording drum. The cost of materials is nominal. What are mainly required are patience and careful workmanship. With these, anyone can make a drum that will give a record sufficiently accurate for practically any ordinary amateur scientific work.

Base. Use well-painted plywood.

Drum. Saw out two three-ply disks and two rings. Mount 1-in. block on faceplate; turn and face it; screw end disks to it for turning. Glue and brad rings to disks. Turn profiles as detailed, with accurate center holes. Paint the insides.

Turn wooden mandrel. Drive on drum ends. Center



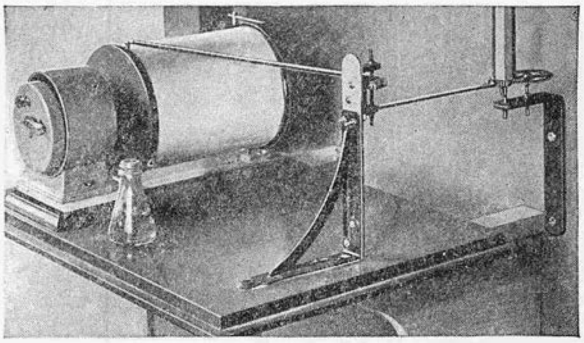
Drum *for Weather Instruments*

It will keep a never-sleeping eye on your wind gauge . . . Can be adapted to other uses

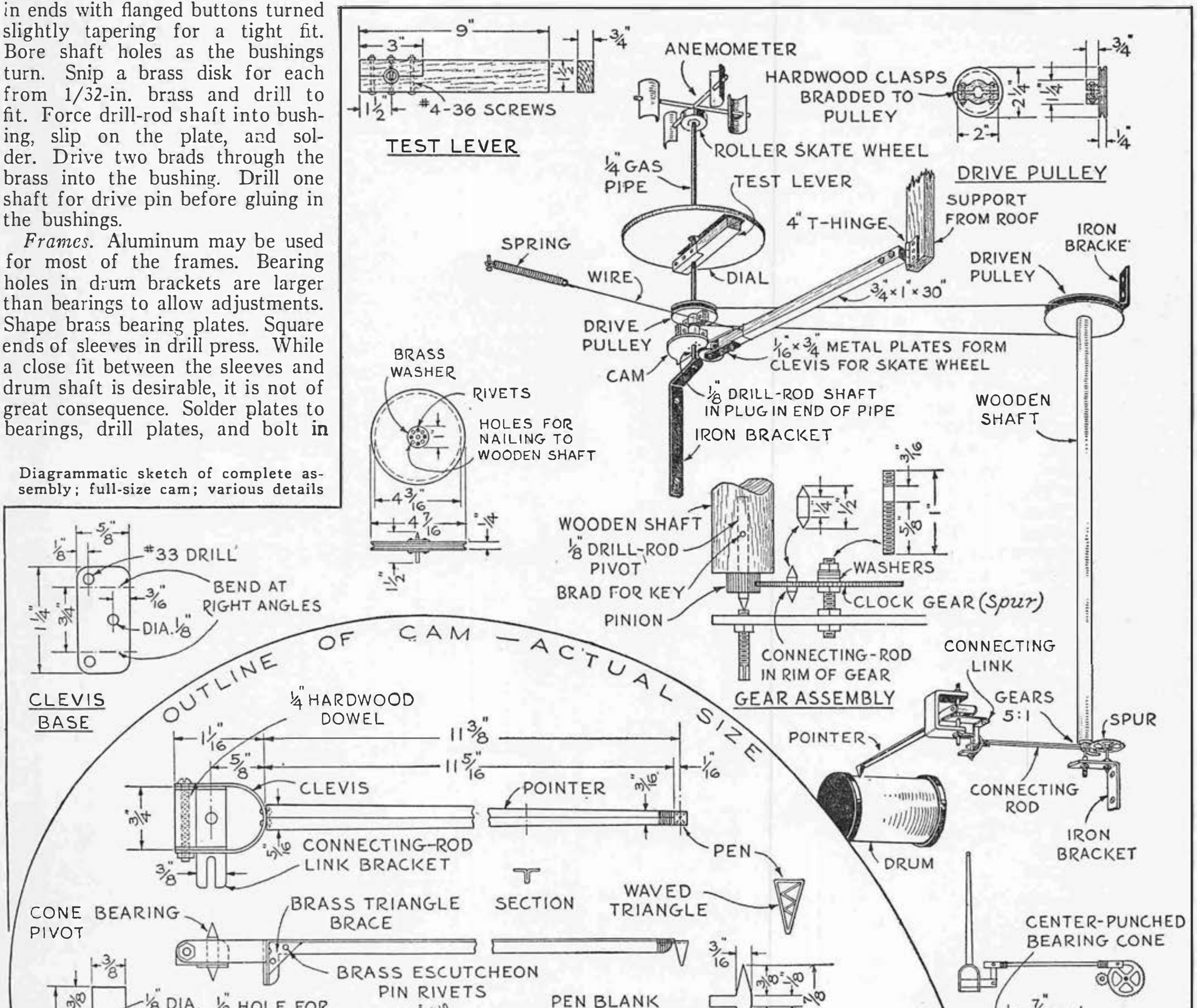
mandrel again in lathe. Rip twenty-six pine strips 1/8 by 5/8 in., 6½ in. long. Tack four temporarily to sheathing rings 90 deg. apart. See that drum ends are square with mandrel. Glue on all strips at ends and edges, removing temporary braces as they are reached. Bind with string at each end. Fill joints with glue and sawdust.

When dry, turn and sand drum round and to accurate circumference of 16 in. After painting, smooth again and test for size. Bush holes in ends with flanged buttons turned slightly tapering for a tight fit. Bore shaft holes as the bushings turn. Snip a brass disk for each from 1/32-in. brass and drill to fit. Force drill-rod shaft into bushing, slip on the plate, and solder. Drive two brads through the brass into the bushing. Drill one shaft for drive pin before gluing in the bushings.

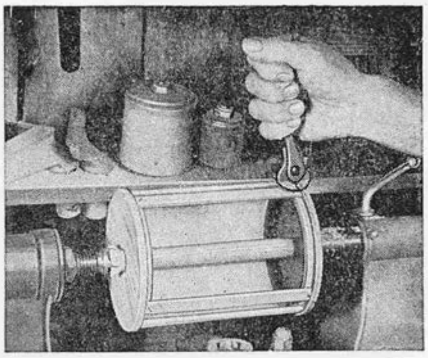
Frames. Aluminum may be used for most of the frames. Bearing holes in drum brackets are larger than bearings to allow adjustments. Shape brass bearing plates. Square ends of sleeves in drill press. While a close fit between the sleeves and drum shaft is desirable, it is not of great consequence. Solder plates to bearings, drill plates, and bolt **in**



As the anemometer turns, its motion is transmitted down, as illustrated in the perspective drawing below, and causes the pen to trace a zigzag record



Diagrammatic sketch of complete assembly; full-size cam; various details



The drum partly sheathed with strips of pine. Each temporary brace is removed when reached

place. These brackets can be bolted directly to baseboard, but it is more convenient to mount them on a metal base strip. This makes possible adjustment of brackets endwise by slipping paper shims under the strip. End play in drum should be restricted. When drum is mounted, force darning needle in drive hole up to the eye. Bind with a turn or two of fine wire through eye.

Solder up a brass standard to hold a wire pointer. Screw it near end of drum. If wire is threaded and a nut put each side of standard, close adjustment is possible. This point is set above drum flange opposite end point of needle swing to indicate position of chart end at start of a run.

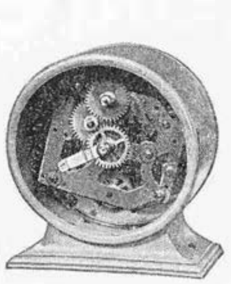
Drive. Use cheap alarm or electric clock. Take out glass, snip off hands, and remove dial. To hour-hand stub, solder an L-shaped piece of 1/16 by ¼ in. brass, having hole in projecting leg to slip over darning needle. Mount clock on a base to raise its center even with drum center.

Pointer. Cut strip of 1/32-in. aluminum 1¼ by 12 in.; fold lengthwise; hammer bend flat; clamp fold between two metal or hardwood strips, and fold wings outward. Hammer them flat also, remove, and trim to width. Mount as shown for sidewise pivoting and with vertical hinge motion for lifting pen to remove or replace chart paper. Bend up sides of clevis base and bolt clevis to it. Use a hardwood dowel over the screw for rigid clamping. Rivet pointer to clevis, stiffening the angle with a brass triangle each side.

The pen is a double triangle of brass, or better, tempered steel. File to point and hone on oilstone. Test writing qualities. If it catches on paper, "write" on a razor hone to smooth it. Attach to pointer with rivets and a wrapping of fine wire.

Pivot. Cut ⅛-in. drill rod about 1¼ in. long. Grip in drill chuck. While revolving at good speed, file cone on end, finishing it, if possible, with superfine flat needle (jeweler's) file. Be sure to get a needle point, then blunt it very slightly by rolling the superfine file over the end as the rod whirls. File other point in the opposite direction, without removing and reversing the rod. As diameter gets small, finish cutting off with light pressure of needle file. Make pivot glass-hard by heating red-hot and dropping in pan of cold water. Sandpaper scale from center, and solder in clevis-base hole.

Bearing Frame. Bend, drill holes, and tap bearing holes. Make bearings by gripping drill-rod stock in vise and prick-punching the end. Finish with a punch made like a pivot, but with a less acute point, so that the pivot makes contact at the very bottom, reducing the diameter to a mere point. Thread bearings, file squares on shanks for wrenches, harden, and screw in place with washers added to lock them. Pointer should move with a fraction of its weight, yet with no bearing play that can be detected. Mount bearing frame on a strip that is bolted in turn to a steel bracket for attachment to baseboard. Pivot center should be opposite center of drum length.



The dial is removed and a brass ell replaces the hour hand for driving the drum

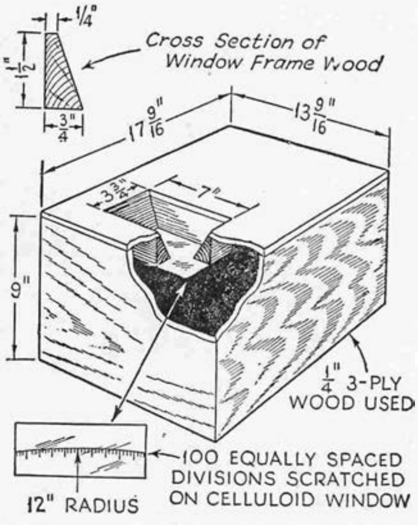
For horizontal alignment, tighten needle clevis so that needle presses against one end of drum. Swing it to other side, and if it does not touch, loosen the drum base-strip screws and shim the strip at that end.

Cover. Center the window over drum, and glaze with sheet celluloid on which 100 equal divisions standing for miles per hour have been scratched. A cross-arc of 12-in. radius indicates motion of pen.

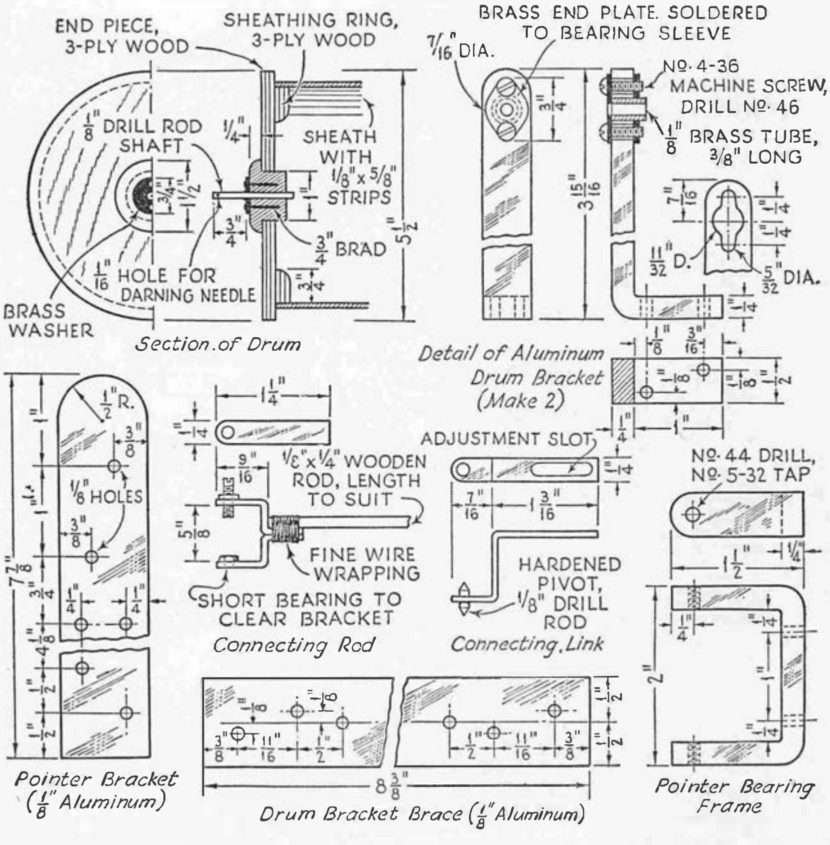
Anemometer Cam. Conversion of the movement into divisions directly proportional to the velocity is made possibly by a cam designed with radii increasing in length as the square of the velocity, pushing a following roller (skate wheel) outward against the tension of a spring. The drawing, outside, is the exact size, and the accuracy of the recording depends on the care with which the cam is made. It can be roughly cut with a hacksaw from ⅛ in. thick annealed tool steel and filed to shape. The reverse curves at the ends fit the skate wheel and act as stops.

Drill shaft hole, make chisel mark on underface at start and end of cam curve, and temper cam like a cold chisel.

Remove clock spring from anemometer and lengthen shaft with ¼-in. gas pipe. Drill a 1/16-in. hole through one end and through the bolt it joins, and put a nail through for a cotter. Also drill cotter holes for test lever and cam. Remount anemometer on roof. (For true measurement of wind velocity, anemometer should be elevated on a mast at least 15 ft. above roof, avoiding eddies and air pockets. In this case the connecting shaft should be a built-up hollow wooden one, made as light as consistent with strength and stiffness.)


1/4"
1/2"
3/4"
Cross Section of Window Frame Wood
17 9/16"
13 9/16"
3 3/4"
7"
9"
1/4" 3-PLY WOOD USED
100 EQUALLY SPACED DIVISIONS SCRATCHED ON CELLULOID WINDOW
12" RADIUS

The cover for the drum has a celluloid window marked with a scale for accurate reading


END PIECE, 3-PLY WOOD
SHEATHING RING, 3-PLY WOOD
1/8" DRILL ROD SHAFT
1/4"
SHEATH WITH 1/8" x 5/8" STRIPS
3/4"
1 1/2"
3/4" BRAD
5 1/2"
1/16" HOLE FOR DARNING NEEDLE
BRASS WASHER
Section of Drum
BRASS END PLATE. SOLDERED TO BEARING SLEEVE
7/16" DIA.
NO. 4-36 MACHINE SCREW, DRILL NO. 46
1/8" BRASS TUBE, 3/8" LONG
3 15/16"
7/16"
11/32" D.
5/32" DIA.
1/8"
3/16"
1/2"
1"
Detail of Aluminum Drum Bracket (Make 2)
1/2" R.
3/8"
1/8" HOLES
7 7/8"
4 1/8"
Pointer Bracket (1/8" Aluminum)
1 1/4"
9/16"
5/8"
1/8" x 1/4" WOODEN ROD, LENGTH TO SUIT
FINE WIRE WRAPPING
SHORT BEARING TO CLEAR BRACKET
Connecting Rod
ADJUSTMENT SLOT
1 3/16"
HARDENED PIVOT, 1/8" DRILL ROD
Connecting Link
NO. 44 DRILL, NO. 5-32 TAP
1 1/2"
2"
Pointer Bearing Frame
11/16"
8 3/8"
Drum Bracket Brace (1/8" Aluminum)

Detail drawings of drum and bearings, pointer bracket and bearing, and connecting rod and link

Turn drive pulley and fit it with wooden clamp, nailed on. Make similar clamp to bolt to cam, and add these to anemometer shaft. For the lower bearing spindle, which resists sidewise motion of cam, insert ⅛-in. drill rod in a hardwood plug driven into end of pipe, keying it with a pin; or better, screw on a cap having the spindle soldered in a hole drilled in it. A rigid steel bracket on wall or suitable support from roof, having a bearing hole for the spindle, completes this assembly.

If skate wheel on follower lever jumps off cam, make it triangular in form, with two well-separated hinges, one above the other, to give rigidity.

Drum Connection. Mount the driven pulley assembly vertically on wall where it can connect with drum mechanism. It is equipped with cone bearings, with gears at lower end.

Support the recording base on brackets at proper level with gears. Make an offset connecting link to clamp to its bracket, having radius equal to radius from center of the spur to center of the pivot in its rim. Two connecting-rod clevises fitted with hardened cup bearings and connected with a wooden rod of suitable length transmit motion from gear to pointer. Owing to play in gear teeth, some lost motion is inevitable, but can be reduced by pressing gears together to bind a little.

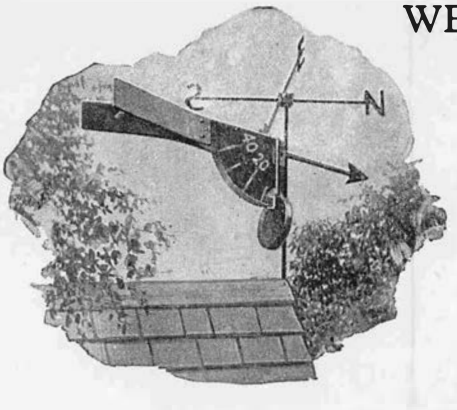
One or more springs may be hooked to follower arm to get necessary tension, and the loop which passes around cam follower can be moved to vary leverage. At 100 M.P.H., when cam has extended springs to limit, the pull at wheel must be about 4 lb. At the start there should be no tension, but the connecting wire should begin to strain the spring as soon as motion starts. In the anemometer twist of 300 deg., the pointer pen moves in a chord of 6 in.; if it moves more, loosen clamp screw that holds connecting link to bracket, and lengthen its lever; if pen moves too little, shorten lever. To bring pen to zero, pivot the link slightly to right or left on its clamp screw.

Adjust tension of spring so that a 1-oz. pull on test lever, with a radius equal to that of the anemometer at the vane center, causes an angular deflection corresponding to the velocity established for the dial calibration (around 12.85 M.P.H.).

Operation: Mount chart paper, and ink the pen. Regular recording ink is best. If this is hard to get, mix a little water color with glycerine, put a drop between the nibs, and the pen will not dry during a 12-hr. run. Since chart papers ruled to fit this drum cannot be purchased and hand ruling would be very laborious, use a plain bond paper held on drum with rubber bands at ends. Start the chart at some convenient time, say 7 A.M, and replace it at 7 P.M.

For reading chart, cut plywood rectangle 7½ by 18 in., and nail wooden strips along the ends and one edge to enclose a chart sheet. Divide the long strip into spaces representing hours, halves, and quarters, and label them to correspond to the chart. Cut a strip of celluloid 4 by 6½ in., trimmed along the edges to curves of 12-in. radius, and scratch division marks for the wind velocities. By laying this over chart and against base molding of board, the velocity at any time can be read. If you prefer, lay out a complete blank chart on a sheet of celluloid.

WEATHER VANE TELLS VELOCITY OF WIND



WHILE it is practically as easy to make as any ordinary weather vane, the one illustrated tells not only the direction of the wind, but also its approximate velocity. The vane itself turns with the wind in the usual way, and the swinging wooden disk is blown back to a greater or less degree.

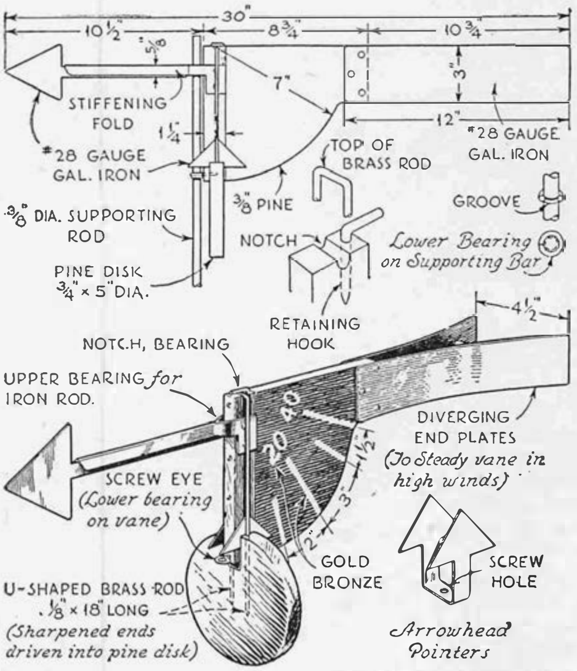
Everyone wants to know from time to time "which way the wind is," as the saying goes. It is the basis for his private local forecast and a good indication as to whether it is going to rain or shine, irrespective of the general weather bureau prediction. Ordinarily there is no weather vane in sight, so it pays to put one up

Although specific dimensions or the type of materials are not important, the accompanying drawings illustrate the original construction and are self-explanatory. The finished vane, mounted on the roof of a garage, is shown in the photograph. In this case the body of the vane was made of ⅜ in. thick pine, with a galvanized iron arrowhead and two galvanized-iron end plates, 3 by 12 in. The latter are spread 4½ in. apart at the end by means of a wooden strip that is nailed between them.

The calibrated radial lines painted on the vane, which represent the degrees of wind pressure or velocity, may be accurately determined by the simple expedient of holding the body portion of the vane out from a moving automobile. The speed as shown on the speedometer produces a corresponding wind pressure on the moving car and, of course, also on the gravity-controlled, swinging disk of the exposed vane. The degree of swing of the disk may be marked on the vane while the car is moving at predetermined speeds.

Any desired type of cross arms with the letters N, S, E, and W may be added, but they should be placed in this case above the vane instead of in the usual position.

In observing the vane during a brisk wind, the extreme degree of swing of the disk gives the approximate velocity, especially when there are sudden puffs.



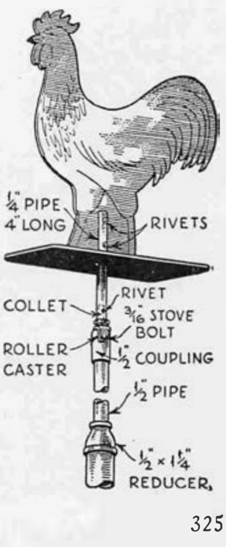
How the vane and swinging disk are made, assembled, and mounted

WEATHER-VANE BEARING MADE FROM CASTER

TO MAKE an efficient weather-vane bearing, use a roller-bearing caster from an office chair. After removing the wheel, slip the jaws over a ½-in. pipe coupling, and drill and tap for 3/16-in. stove bolts where the holes of the jaws come, to secure the bearing to the coupling. This leaves the tailpiece upright and ready to receive the vane.

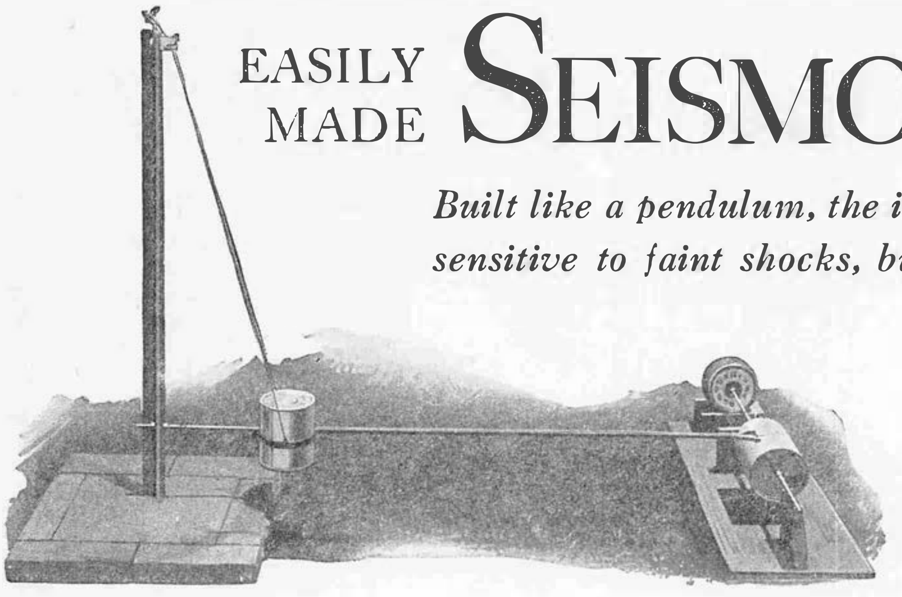
The vane is 18-gauge galvanized iron. Take a piece of ¼-in. iron pipe 4 in. long, put two hack-saw blades in a frame and saw a slot lengthwise of the pipe for 2 in., and press this on the vane, riveting it securely. A plate with a hole in it slips over the pipe, as shown, and is soldered to the bottom of the rooster. This plate and the metal between the legs were painted leaf green (any other dark color could be used), and the legs were painted yellow. In this way the necessity of making separate legs was avoided, yet from the ground the appearance is quite natural.

The collet or socket of the caster, which originally pressed into the leg of the chair, just fits the ¼-in. pipe, so press this into the pipe and put the tailpiece into the socket, after wrapping a piece of tin around the tailpiece to make it fit. Drill through the pipe and tailpiece to receive a finishing nail, which acts as a rivet..



EASILY MADE SEISMOGRAPH

Built like a pendulum, the instrument is amazingly sensitive to faint shocks, but not to nearby traffic



Complete seismograph and recorder. Earthquakes from 200 to 6,100 miles away have been registered

THIS very instant the ground trembles beneath your feet. The earth's crust, seemingly, is never at rest; and somewhere in the world, perhaps in the center of a continent, possibly beneath some ocean, a quake is in action that may send its vibrations around the globe. For sheer unbelievable, horror-tinged experience, with the terror of a nightmare imposed on reality, there is nothing quite like a stiff earth shock. To the accompaniment of low-pitched rumbling, the ground writhes, trees sway, and buildings crash, while the sickening realization comes that there is no rigid thing left to which you can cling for support.

No one knows when or where an earthquake will occur. For this reason scientists are studying earth movements, and have learned much of the nature of such disturbances, as well as what can be done to lessen damage from them.

By building a seismograph similar to the one illustrated, you can make a hobby of quake recording yourself. You may have to wait only a few hours after completing it to check up on a shock, and at most only a few days will elapse. This seismograph has recorded forty-three earthquakes within six months, varying in distance from 200 to 6,100 miles. Although it is located within 75 ft. of heavy street traffic, no bad effects are noticeable.

This instrument consists of a horizontal pendulum suspended by a fine wire from an upright post in a heavy foundation. When the earth trembles, the bob, freely suspended, remains almost still while the post and pivot vibrate. A delicate point at the end of a long, light arm fixed to the bob magnifies the movement of the ground and scratches the record of it on a smoked paper wrapped around a revolving drum.

The post is an angle iron drilled as detailed in the drawing. Set it up in a concrete foundation about 16 in. square and 9 in. high; or a shell of bricks may be built up, and concrete poured in the center. While this hardens, make the other parts.

The bob, or weight, is of lead, melted and poured into a can about 3 by 3½ in. The dimensions may vary somewhat. If the can is packed in damp sand, the hot metal will not run out when the seams open.

In the center of the side of the weight, drill and tap a ¼-in. hole, ¾ in. deep. Thread a ¼-in. brass rod 5 in. long at one end to screw into the bob, and if it is too loose, make a few dents in the lead. Cut off the end of the rod so that the distance to the center of the weight is 5¾ in., and drill a hole in the end slightly larger than an extra-loud phonograph needle, of such depth that the inserted needle will be exactly 6 in. from the point to the bob center. A little solder melted into the hole around the needle will fasten it.

In the center of each side of the weight, at right angles to the rod, drive a small finishing nail, allowing the head to project about ¼ in. Attach a stirrup of No. 14- or 16-gauge iron wire to these nails with loops, and tie the suspension wire to the center, thus bringing the point of suspension to the center of the bob.

Three adjustment points are provided in the seismograph. The upper, or wire adjustment (*A* in the diagram) consists of a threaded brass rod bent L-shaped and pierced with a small hole. It is screwed into a bracket consisting of a brass plate with the upper end bent back at a little more than 45 deg. A lock nut behind the bracket keeps the adjustment rod from changing position.

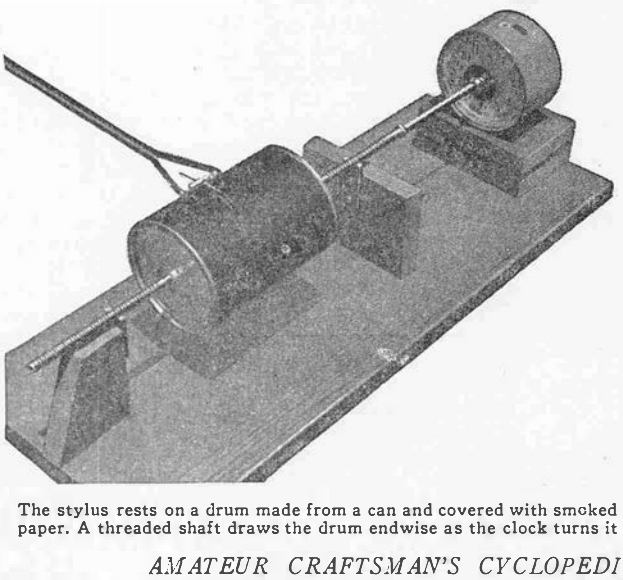
Adjustment B, for shifting the upper support sidewise, is a piece of ⅛ by ¾-in. brass bent U-shaped, with a 3/16-in. threaded brass rod running through the ends. The U is not threaded, serving merely as a bearing for the rod, which is kept from end motion by two nuts that are soldered to the rod after being tightened against the U. The U, together with the bracket for *A* adjustment, is fastened to the post with a ¼ by 1-in. machine bolt.

Adjustment *C* is made of ⅜-in. brass rod threaded full length, with a slot cut in the rear end for a screw driver. To the other end solder a cone cup bearing from an old clock balance wheel, as a pivot for the phonograph needle in the bob rod. Supply the adjusting screw with a nut before and behind, after inserting it in the lower hole of the upright, and tighten it with the cup bearing about ½ in. from the surface of the post.

Make the extension arm of 30-gauge aluminum, forming it into a tapered channel by folding up the sides as indicated. The small end terminates in a Y formed by cutting out the bottom and spreading the sides to accommodate the stylus assembly.

For attaching the arm to the weight, make a sheet-brass clamp ½ in. wide and 10 in. long to bind around the bob, where it is held with a screw and nut in the bent-out lugs, as shown. A strip of brass ½ by 4½ in., with ½ in. at one end bent at right angles, is soldered to the clamp and fastened to the extension arm with two small bolts.

To assemble the machine, thread the suspension wire (a fine music wire, such as a guitar E-string) through the hole in adjustment rod *A*, and rest it between threads on adjustment *B*. Turn *A* until the pendulum, with the needle tip in the bearing of *C*, is horizontal from the bearing to the bob center. The weight should



The stylus rests on a drum made from a can and covered with smoked paper. A threaded shaft draws the drum endwise as the clock turns it

Records Distant Earthquakes

come to rest with its rod at right angles to the face of the angle iron, the necessary adjustment being made by turning the rod of *B*.

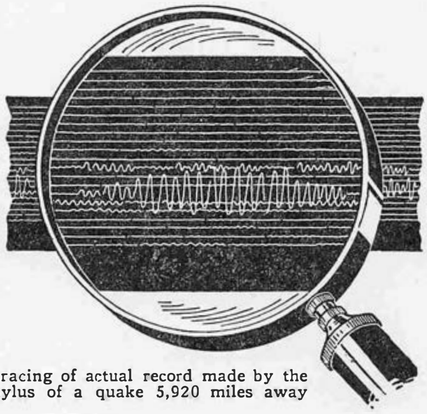
You now have a horizontal pendulum with a definite period of oscillation. The period is the time in seconds required for the weight to make a swing back and forth. With the pendulum in motion, and using the farthest movement to the right as a starting point, check the time in seconds required for the weight to move to the left and back to the starting point again.

After your first adjustment, the period will probably be six or eight seconds. To change it, shift the pivot outward, nearer a point directly below the upper support, by loosening the nut on the rod behind the angle iron and tightening the front one. Continue moving the pivot outward until the pendulum has a period of twelve seconds.

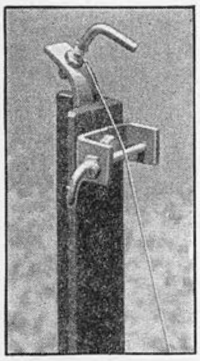
If the seismograph is placed out of doors it should be in a dry, shady spot, and a larger foundation should be used, or water seepage under the foundation will cause the needle to wander off the paper. Place a screen around the instrument to prevent the wind from blowing directly on the pendulum, which is very sensitive to air currents around it. If the currents are very troublesome, the seismograph should be entirely inclosed.

The recording drum is simplicity itself. Obtain a tin can of about the size indicated and mount it on a ⅜-in. brass tube for a shaft. One end of it is threaded, while the other is left smooth and terminated by a washer having a square hole in it slightly more than ⅛ in. on a side.

Bearings are made by drilling bar brass to receive the shaft and mounting screws. Drill one 7/16 in. in diameter and thread it to fit the shaft threads, but drill the other ⅜ in. for a plain bearing. Having cut off the ends, screw the plates to the mounting blocks shown in the drawings,

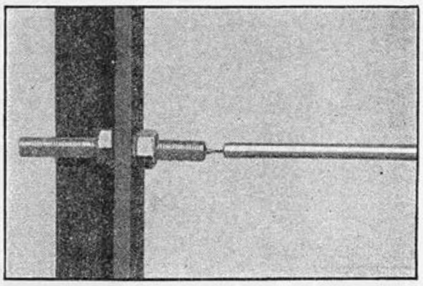


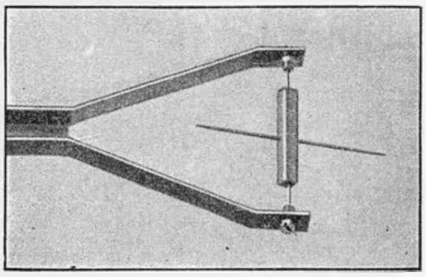
Tracing of actual record made by the stylus of a quake 5,920 miles away



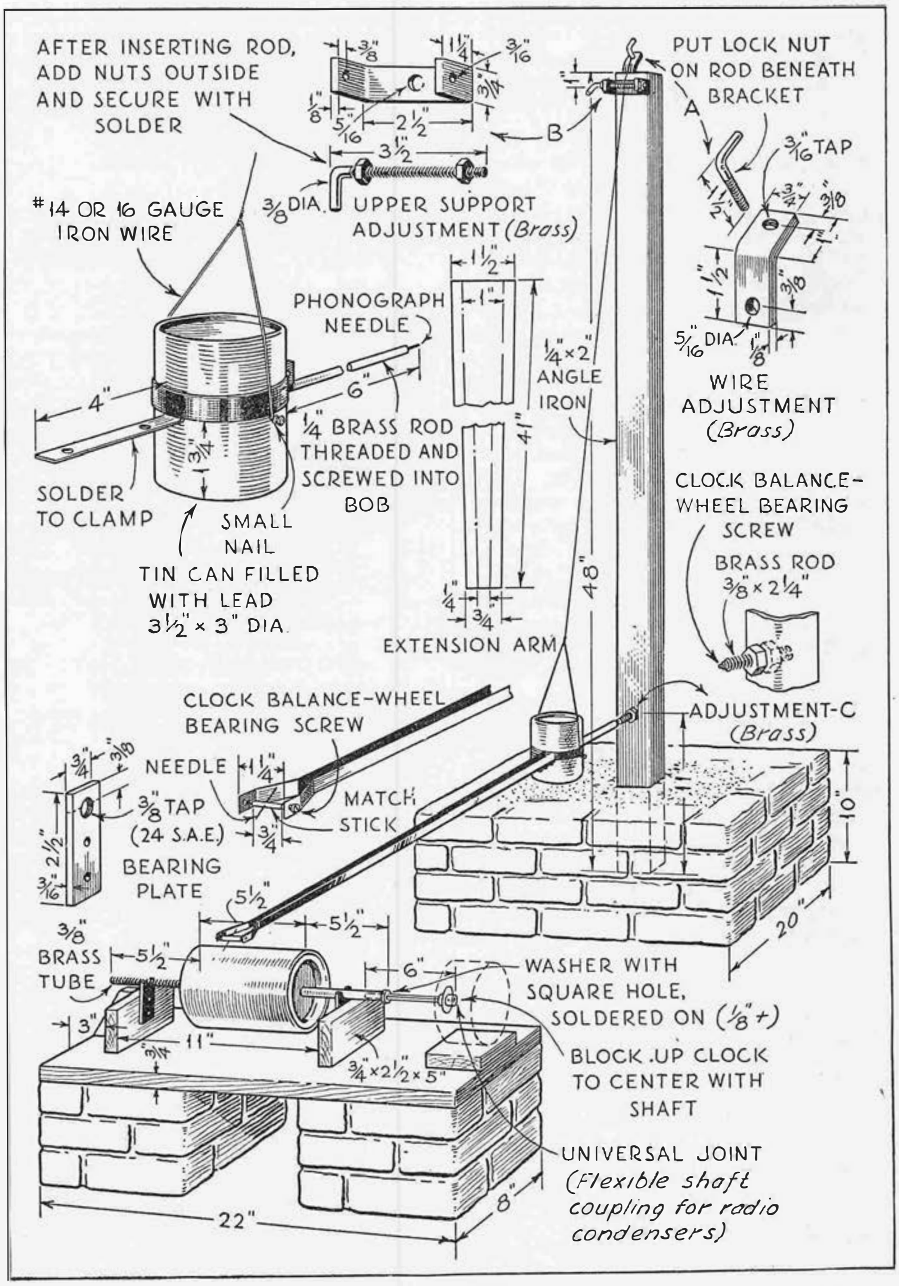
Close-up of top of post showing method of adjusting the wire accurately in respect to length and position. These parts are marked *A* and *B* in the drawing

Below is the pivot and the adjustment that is marked *C* in drawings. A cone cup bearing from an old clock balance wheel and a phonograph needle form the pivot



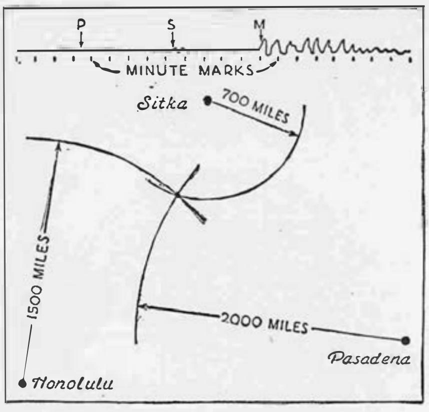


A detail photograph of the stylus mounting. Note that the needle is counterbalanced so as to exert very little pressure on the drum



AFTER INSERTING ROD, ADD NUTS OUTSIDE AND SECURE WITH SOLDER
3/8"
1 1/4"
3/16"
3/4"
1/8"
5/16"
2 1/2"
C
B
3 1/2"
3/8 DIA.
UPPER SUPPORT ADJUSTMENT (Brass)
#14 OR 16 GAUGE IRON WIRE
PUT LOCK NUT ON ROD BENEATH BRACKET
A
3/16" TAP
1 1/2"
3/4"
3/8
1 1/2"
5/16" DIA.
1/8"
WIRE ADJUSTMENT (Brass)
PHONOGRAPH NEEDLE
4"
6"
3/4"
1/4" BRASS ROD THREADED AND SCREWED INTO BOB
SOLDER TO CLAMP
SMALL NAIL
TIN CAN FILLED WITH LEAD 3 1/2" × 3" DIA.
1 1/2"
1"
41"
1/4"×2" ANGLE IRON
48"
1/4"
3/4
EXTENSION ARM
CLOCK BALANCE-WHEEL BEARING SCREW
BRASS ROD 3/8"×2 1/4"
ADJUSTMENT-C (Brass)
CLOCK BALANCE-WHEEL BEARING SCREW
NEEDLE
3/8" TAP (24 S.A.E.)
BEARING PLATE
2 1/2"
3/16"
MATCH STICK
10"
20"
3/8" BRASS TUBE
5 1/2"
3"
11"
6"
3/4"×2 1/2×5"
WASHER WITH SQUARE HOLE, SOLDERED ON (1/8"+)
BLOCK UP CLOCK TO CENTER WITH SHAFT
UNIVERSAL JOINT (Flexible shaft coupling for radio condensers)
22"
8"

How the seismograph is set up and details of the more important parts. The dimensions are those of the original, highly successful instrument that is shown in the photographs.



Three-station method of computing location of an earthquake. Each station calculates the distance by the variation of the wave time; then scale radii are used to strike arcs, all of which intersect at the epicenter

which in turn are held upright by a base board. If the drum is rotated, it will be drawn endwise corresponding to the lead of the screw, and thus a continuous line is traced by the stylus. Driven one revolution per hour by a small electric clock, the paper will last several days without changing.

BLOCK up the clock until central with the tubing. Remove the hands, and attach a radio universal joint to the hour-hand shaft. To the other side secure a steel rod ⅛ in. square, having its other end thrust through the shaft washer, thus providing a drive for the drum, no matter what its endwise position.

The drum assembly must be blocked up to such a height that the drum is a little below the level of the extension arm tip.

Friction between the stylus and the paper on the drum must be reduced to a minimum, and this is accomplished by the use of a counterbalanced needle. Cut a match stick ¾ in. long, cut two small sewing needles in half, and put the pointed halves in the ends of the stick. Run another small needle through the center of the match so that a cross will be formed. It is the point of this needle that traces the line on the smoked paper.

For pivot bearings, make a small hole in each side of the Y with an ice pick, and screw in two clock balance-wheel cups. Mount the stylus pivot between them. After a few trials the tracing needle can be balanced so that the point will rest very lightly on the paper.

Highly glazed paper, such as enamel-finished book paper, should be used for the record, since its smooth surface will hinder the movement of the needle but little. Almost every printing shop carries some in stock. Use a kerosene lamp to smoke the paper, turning the flame high and holding the paper above it until a black deposit of soot has been deposited.

Sometime during the recording, mark the position of the stylus at 12 m., so that time can be reckoned from it. After recording, fix the sheet by spraying it with a solution of six parts alcohol to one of white shellac, and use it as a negative, if desired, for printing the permanent record on photographic paper.

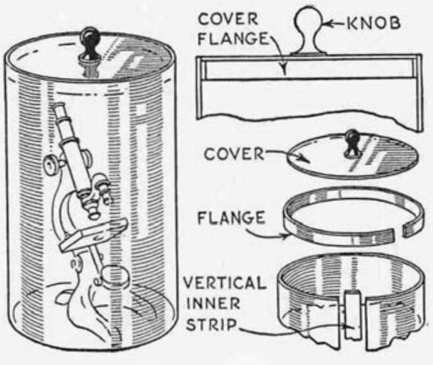
The seismograph, of course, will register only shocks that vibrate somewhat out of the plane of the post and arm. To receive quakes from all directions, two instruments should be built and set up at right angles to each other.

When there is no disturbance, the pendulum will remain stationary and the needle will trace a straight line on the smoked paper as it moves beneath it; but when waves from a distant quake pass beneath, the needle will swing from side to side, sometimes less than ⅛ in., sometimes 1 or 2 in. Large or small, each line will create a desire to learn more about the science of seismology.

Having obtained a record, you will want to know the distance and location of the earthquake. The distance can be estimated fairly accurately. Avoiding technicalities, it may be said that three main waves emanate from the usual shock. The first or primary (*P*) wave travels fastest. A slower secondary wave (*S*) comes a little later, registering on the paper, and later still a third, or main (*M*) wave. They start together, and diverge more and more as they travel from the source, and their rate of travel has been measured. Thus charts have been prepared that show from the time-separation of the recorded waves the distance to epicenter, or the area of ground immediately above the disturbance.

The location of a quake is learned by obtaining a card from the U. S. Coast and Geodetic Survey giving the data, or it can be computed from the records, as illustrated in the diagram.

TRANSPARENT COVER PROTECTS MICROSCOPE



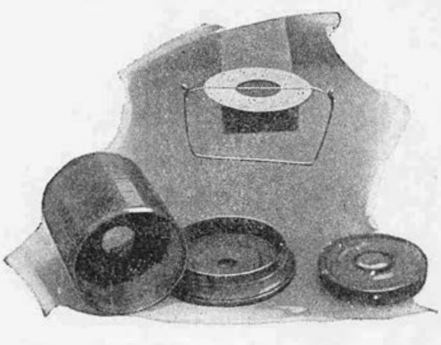
A LIGHTWEIGHT, unbreakable, and transparent cover for your microscope can be made from sheet celluloid, celluloid cement, and a small knob. The drawing shows how the cover is assembled. Small cuttings of celluloid dissolved in acetone or amyl acetate form a good celluloid cement. Glacial acetic acid can also be used alone as a glue, but you will find it rather messy, and the fumes are disagreeable. Small C-clamps will hold the material together while the cement dries.

CRYSTALLIZED LAMPS

A NEW crystal finish for electric light bulbs which has lately become popular for novelty effects in place of the usual "frosting," can be produced by dipping the lamps in a solution of 1 pt. distilled water, 1 oz. of pure dextrine and as much sulphate of zinc as the solution will dissolve. To this may be added small quantities of aniline dye for giving any desired color, although too much dye will spoil the effect. The crystal finish does not appear until the globes have become thoroughly dry. If they are to be exposed to the weather, give them a thin coat of clear lacquer.

MOUNTING CROSS HAIRS MADE OF SPIDER WEB

CROSS hairs of some description are an essential part of such optical instruments as transits and finder telescopes when it is necessary to locate some object accurately within the field of view. The finest of all cross hairs are those made from spider web, and when the correct methods are used, they are easy to install.



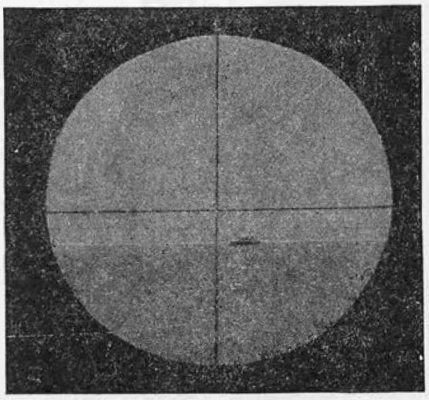
How a bow-shaped piece of wire is used to set cross hairs over a telescope diaphragm

A cell or diaphragm of thin metal or cardboard is required to carry the cross hairs. It should be just large enough to fit snugly within the tube of the instrument, and the center hole should be but slightly larger than that of the regular diaphragm. After accurately marking off one surface into quarters, lay the diaphragm near the end of some projecting support, as shown.

A small U-shaped bow is made from a piece of fine, stiff wire such as a wire violin string, and a tiny bit of wax or chewing gum is affixed to either end. A suitable strand of uniform thickness from the radial lines or brace lines of a spider web is now located and secured to the bow with a couple of turns about each waxed end.

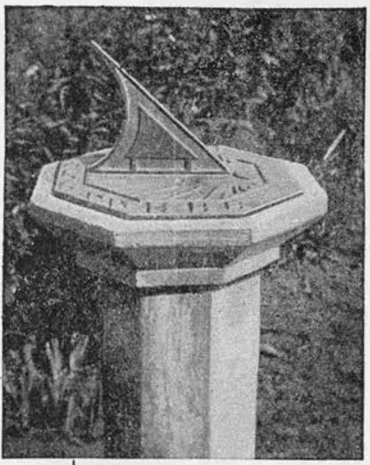
The web should now be laid directly across the center of the diaphragm. The weight of the suspended bow serves to stretch the web tightly. Secure the web at each end with a drop of shellac or glue; and when this has hardened, clip off the ends of the web, give the diaphragm a quarter turn, and repeat the process with a second strand.

The entire cell should be carefully pushed into the tube or eyepiece of the instrument to the position which gives the cross hairs the most perfect focus. Applying a few drops of glue will serve to keep it permanently in position.

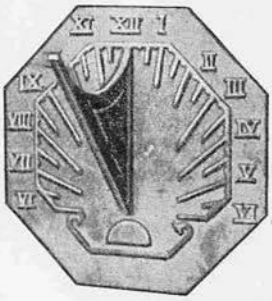


Two strands of spider web set in a telescope finder. They are the best of all cross hairs

NEW AND EASY WAY TO
Lay Out *an* Accurate SUNDIAL



Decorative garden sundial made of two brass castings set on a concrete pedestal



The assembled dial and, at left, diagrams for laying out the patterns, together with plans for the pedestal

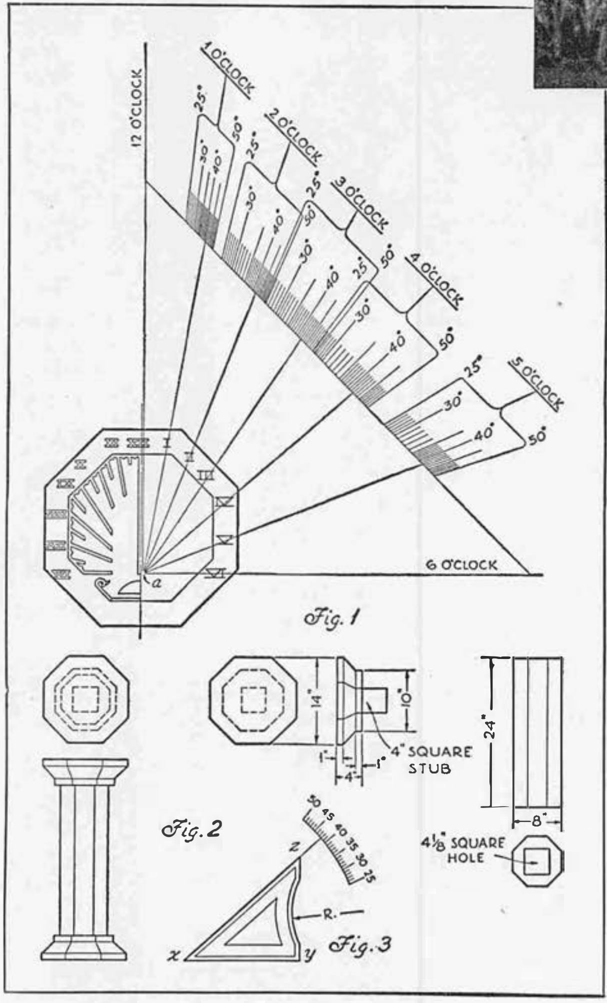


Fig. 1

Fig. 2

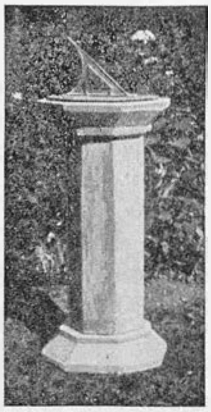
Fig. 3

SUNDIALS are as popular today as they were three thousand years ago—but for entirely different reasons. Three thousand years ago they were man's only timepiece; today they are highly regarded as garden decorations.

A horizontal dial, such as the one illustrated, consists of the dial and the pedestal. The dial itself is made in two sections, the gnomon and the face. The latter is a flat plate, divided to measure the shadow the gnomon throws upon it. Although usually made in one piece, the gnomon is composed, in theory, of two parts. The upper inclined surface, which casts the shadow, is called the style, while the lower portion, by which it is fastened to the face, is known as the foot.

Before the actual construction can begin, you will need to lay out the dial and gnomon. As the dial is to be 12 in. in diameter, a fairly large sheet of paper will be required. To be accurate, both the dial face and the gnomon must be figured according to the latitude of the town or city where the dial is to be used. This may be found with sufficient precision by looking at any good map.

Figure 1 makes it very easy for anyone residing in the United States to lay out a dial face. All hour lines have been figured, and all that you need to do is find your latitude under each hour line and draw a line from it to point *A*. Notice that point *A* is not in the exact center of the dial; it is 3/16 in. to the right of it. The hours from six to twelve are projected across the dial, leaving another 3/16 in. between the center line and the point corresponding to *A*. This means that you will have a space ⅜ in. wide in the center of the dial. This is for the gnomon. Half- and quarter-hour lines are equal divisions of the space between hour lines. All markings are made 3/16 in. wide with the exception of the numerals, which are ⅛ in. wide.



The cast concrete pedestal is formed of three sections

Transfer the drawing of the dial face to a piece of wood, 12 in. square and ¼ in. thick. Out of this, cut a 12-in. octagon. Now, glue thin strips of wood, 3/16 in. wide by ⅛ in., over all the hour lines and the decorations at the bottom. The numerals are made of ⅛-in. square wooden strips. A piece of ⅛-in. wood, ⅜ in. wide, is glued on where the gnomon is to be placed.

When every piece has been glued in place, all sharp corners between the strips and the dial face must be rounded in with wax. Sharp edges on the strips are smoothed off with a knife, and finally the entire pattern is sandpapered smooth and given two or three coats of thin orange shellac.

The gnomon is laid out as in Fig. 3 Line *X Y* is 7 in. long for our particular dial. *X Z* is inclined at an angle from line *X Y* equal to the latitude of your location. Point *Z* must be exactly over point *Y*. Radius *R* can be any arc that looks well. A ⅛-in. border is drawn around the edge, and a simple design is placed in the center.

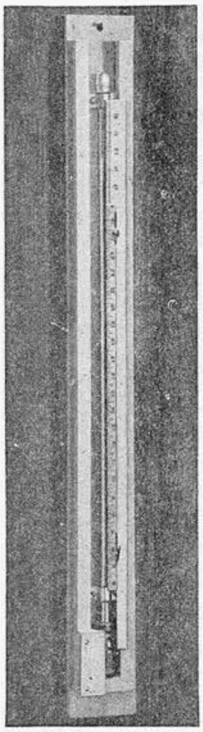
Using carbon paper, transfer this drawing to a piece of wood ⅛ in. thick. Saw this out, glue ⅛-in. square strips around the edge, and fasten on the decoration, made of thin wood. These strips and the decorations should be glued on both sides of the gnomon. Round all corners with wax, sandpaper the wood, and finish with two or three coats of shellac.

Both patterns are now ready for the foundry. The cost of brass castings the size of these is very reasonable. Go to the foundry yourself, if possible, and get the castings as they are removed from the sand. Clean them wire a wire brush, grind or file off any marks, and polish all high spots with an abrasive stone.

The gnomon is attached to the dial face with two machine screws. Two holes also should be drilled in the face for wood screws to be used later for attaching the dial to the pedestal.

The completed dial should not, of course, be placed where a tree or building will cast a shadow upon it. It must be set so that twelve o'clock is pointing absolutely north. The dial must be level, and the gnomon should not incline to either the left or right. On April 15th, June 15, September 1, or December 24, turn your dial so that it agrees with any good watch, and you may then be sure your dial is pointing north.

Making a Mercury
FOR YOUR HOME



The most important instrument in weather forecasting is the barometer. It infallibly reports the "highs" and "lows" by what may be considered as a process of "weighing" the air. The principle of the mercury barometer is shown at left, the measurement being taken from the level of the mercury in the cistern to the top of the column. At the right is a simple homemade barometer

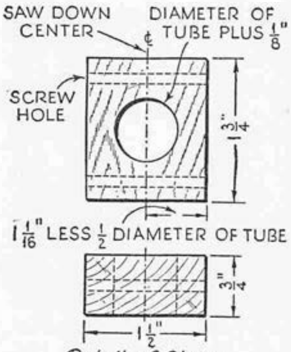
IF THE barometer is falling, beware of weather! Sudden sinking of the mercury means lowered atmospheric pressure, which in turn usually presages storm—an inrush of denser air, cold or moisture-laden, to displace the lighter rising air. When the column regains its normal height, look for fair skies soon.

The barometer, in effect, weighs the air. To illustrate this, seal a glass tube at one end and fill it with mercury. If you close the open end with your thumb and upend the tube in a dish of mercury, some of the liquid metal will run out, leaving a vacuum above it. Air pressure keeps most of the mercury in the tube, the amount depending on the elevation, the temperature, and weather conditions.

Since the height of the mercury column varies with the air pressure, and storms usually follow the movement of low-pressure centers across the country, it is evident that a barometer is essential to your back-yard weather station; and the mercury type, being so simple in construction, is a first-rate project for your home shop. Obviously, you must add to the tube and dish a rigid support of some kind equipped with guards to prevent breakage of the glass, but the labor of making it is almost negligible. You probably have a smooth board on hand that will furnish all the needed lumber.

At a drug store purchase a round glass bottle about 1 in. in diameter and 3 in. high, fitted with a composition screw cap. A suitable glass tube also must be obtained. One easy way to get it is to buy a gauge glass of 3/8-in. bore and 3 ft. in length, which is stocked by most hardware dealers. This size usually sells for about 90 cents. Regular barometer tubing with one end closed can also be bought from dealers in scientific supplies. Mercury costs about $1.50 a pound, and 2½ lbs. will be required for this tube. If you can obtain a glass with an inside diameter of 1/8 in., only 9 oz. will be needed, and other sizes, of course, will be in proportion.

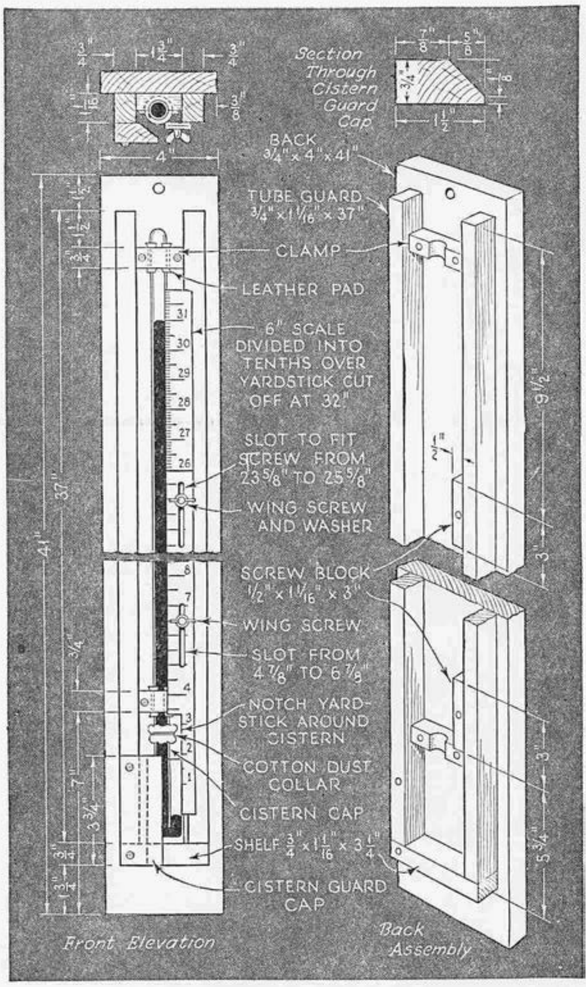
A suitable back is suggested in the drawings on this page. The guard strips may be varied in size, so long as the tube stands free, is protected from accidental blows, and yet can be easily read. To make the clamps, bore holes 1/8 in. larger in diameter than the tube (to allow for leather pads) and rip them through the center. Tack the halves to the backboard and drill the ends to receive screws. Cut tin strips to clasp the outside of the tube. Make the cistern guard cap, add the cistern shelf, and paint the assembly with two coats of boiled linseed oil.



Detail of Clamp

Bore the bottle cap to fit loosely over the tube. As there is some danger of cracking the composition, it is best to drill a 3/8-in. hole and then enlarge it with a round file. If there is a metal-foil liner in the cap, remove it, for the mercury might attack it.

Filling the tube must be done with considerable care. Pouring the mercury in and stopping the opening with the thumb is all right for an experimental barometer, but it is not satisfactory for continued use, because, in filling, large numbers of air bubbles are trapped. Many of these


Section Through Cistern Guard Cap
BACK 3/4" x 4" x 41"
TUBE GUARD 3/4" x 1 1/16" x 37"
CLAMP
LEATHER PAD
6" SCALE DIVIDED INTO TENTHS OVER YARDSTICK CUT OFF AT 32"
SLOT TO FIT SCREW FROM 23 5/8" TO 25 5/8"
WING SCREW AND WASHER
SCREW BLOCK 1/2" x 1 1/16" x 3"
WING SCREW
SLOT FROM 4 7/8" TO 6 7/8"
NOTCH YARDSTICK AROUND CISTERN
COTTON DUST COLLAR
CISTERN CAP
SHELF 3/4" x 1 1/16" x 3 1/4"
CISTERN GUARD CAP
Front Elevation
Back Assembly
41"
37"
4"
9 1/2"
3"
5 3/4"

How to mount a mercury barometer. It consists merely of a glass tube and a small bottle or cistern set up on a board with a scale that can be adjusted to show the height of the mercury

Barometer

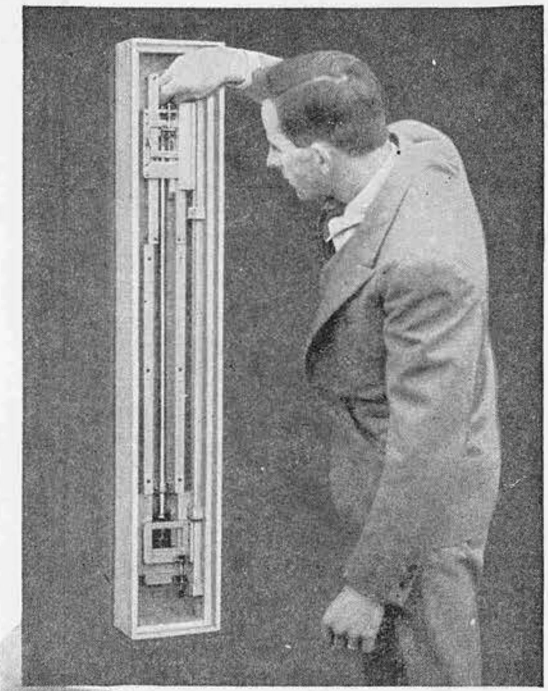
WEATHER BUREAU

can be worked out, but in spite of all possible care hundreds of tiny bubbles remain scattered through the column. In the course of time, some of these bubbles may work to the top and spoil the vacuum.

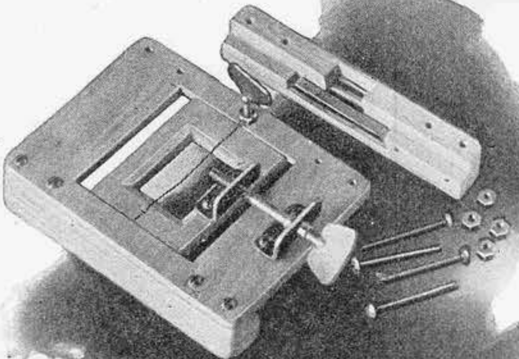
Fortunately, the filling can be done without much trouble. If you find it unhandy to do the job at home, you can probably get permission to work in your local high-school laboratory. First the tube must be sealed at one end. Warm it for some distance back from the end, moving it back and forth in the flame and rotating it with the fingers. Then concentrate on the very end, continuing to turn the tube until the glass softens. The closing can be speeded by pushing the glass inward with an iron rod. Continue heating until the glass runs together in a smooth blob.

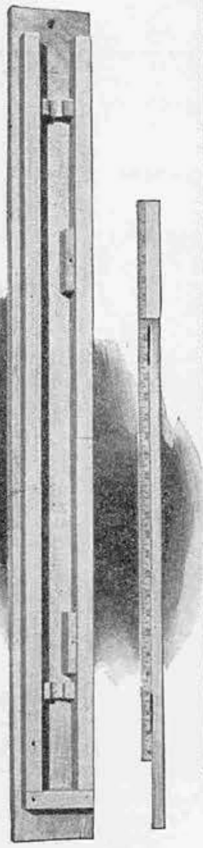
No matter how clean the tube appears to be inside, it must be considered dirty. To clean it, make a solution of 1 part nitric acid to 20 parts water, and nearly fill the tube with it. Cork with a rubber stopper and shake for a minute or so; then empty, rinse with tap water, rinse again with distilled water, and stand aside to drain for a quarter of an hour. Now fill the tube with strong alcohol and pour out, repeating eight or ten times, to remove the water, and drain for at least half an hour. The tube is then ready for use. For best results, however, the bottle should be treated the same way.

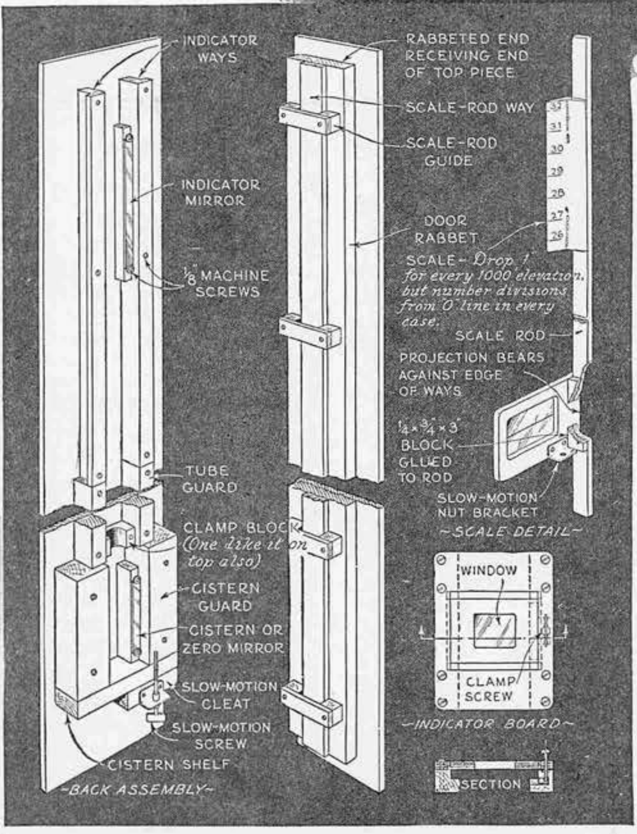
As there is some danger of spilling the mercury, it is a good idea to do the pouring over a large crock or enameled kettle. Warm the tube and a quantity of quicksilver, and, using a funnel, pour in enough to fill the glass 3 or 4 in. deep. Holding the tube lightly in the fingers, heat it gently in a Bunsen flame, turning and moving it up and down to prevent excessive local heating. As the temperature of the mercury nears the boiling point, air and moisture are driven out and form tiny silvery-white bubbles, which coat the interior of the tube and give it a frosted appearance. These bubbles enlarge, but after the mercury boils for a while they disappear entirely. Further boiling takes place with sharp clicks as the metal spashes about, an indication that it has continued long enough. Now add a fresh quantity of warmed mercury and repeat. You can easily see the line of separation between the treated mercury and the new. Continue the process until the tube is nearly filled. The last 2 or 3 in. of the tube are then filled without boiling.



Here is a more elaborate barometer than the one shown on the facing page. It has an indicator at the top with a slow-motion screw, the parts being illustrated at the left





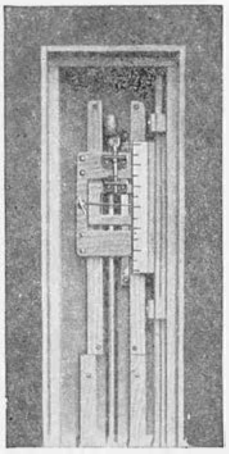


A. suggestion for making the improved barometer. The scale is moved up and down by a slow-motion screw at the bottom; then the indicator at the top is adjusted with extreme accuracy as in the upper photo

It is not possible, of course, to use the thumb to stop the tube, as the cistern opening is far too narrow. However, a disk of waxed cardboard makes a good substitute. Holding the tube vertically in the crock, lay the disk over the end and clamp it there by turning the cistern bottle upside down over it. Thus sealed, the tube and bottle can be turned right-end up. Still holding the two firmly together, pour a little mercury into the cistern—enough to fill it about ½ in. deep.

At this juncture the assembly should be fixed to the supporting back, which of course must be held firmly upright. Lift tube and bottle together and set them on the shelf between the guards. Slip a strip of soft leather between the tube and each clamp, fold the ends over in front, and screw on the tin strips, leaving them loose enough to allow the tube to be moved. Cautiously raise the tube ⅛ in. to let the mercury assume its level, and tighten the clamps. Keep a sharp eye on the column while this is being done, for if by accident a bubble of air enters the tube, it will have to be filled again. This will not happen if the open end is kept below the cistern level at all times.

REMOVE the cardboard disk from the bottle by fishing it out with a pointed wire, for if this is not done it may act as a check valve to prevent the inflow of mercury when the column rises.



Indicator at top of the improved barometer

If the barometer is set up in fair weather, the bottle may overflow in times of low pressure, since a falling column means a rise in the cistern level. To prevent such waste, suck out enough mercury with a medicine dropper to lower the cistern level to ¾ in. in good weather.

When the bottle has been pushed back into place, screw down the lid. Tie a collar of fluffy cotton around the tube and push the cotton down against the cap to keep out dust.

All that remains is to arrange a reading scale. This may be nothing more complicated than a yardstick hung from a nail in the back. A much better plan is shown in the drawing. Here the yardstick has been pierced by two slots and permanently screwed to blocks inside one guard strip, with a wing screw (which may be a common screw with a metal fin soldered in the slot) in the lower one to clamp it with. Since a barometer is read to tenths of an inch, the six inches of the stick where the movement of the column top takes place is covered with a scale of tenths glued and bradded on.

To read the barometer, loosen the wing screw and shift the scale to bring the zero mark even with the crown of the mercury in the cistern. Then note the height of the column, again reading to the crown of the mercury curve.

You may also add, if you wish, a sliding pointer of some kind that can be moved to the level of the mercury whenever you take a reading. The next time you look at the barometer you can then tell at a glance whether the mercury is lower or higher, and that is frequently all you wish to know.

THE scale gives all the reading required to keep a record of atmospheric pressures in your own locality. However, if you want to compare it with barometer readings in other places as reported in newspapers and shown on weather maps, you will have to figure what the reading would be at sea level with the thermometer at 32 deg. F., because official barometer readings are all reduced to this standard. In fact, for precise work, they are further corrected to 45 deg. latitude, but such correction is so slight that you may disregard it. The following simple rules are for standardizing:

1. Temperature. Mercury expands with warmth, and naturally, with a given atmospheric pressure, the barometer in the warmest spot stands the highest. For every degree increase F., each inch of the column lengthens 1/10,000 in., which amounts to quite a little, as a practical example will prove. Suppose that on a bright June day your barometer stands at 29.6. This same column, under the same air pressure, if cooled from a summer temperature of say 90 deg. to freezing temperature 58 deg. F. lower, would shrink 58 x 29.6 x 0.0001, or 0.17 in., which is nearly 1/6 in. On the other hand, if the reading were taken in January with the thermometer 26 deg. below zero, a correction of 0.17 in. to be added to the reading would be necessary, since freezing point is 58 deg. above the barometer temperature. Therefore:

To correct for temperature: Multiply the column reading in inches by number of degrees above or below 32 deg. F., and multiply the product by 0.0001. If the temperature is above freezing, subtract the correction; if below, add.

2. Altitude. Every 106 ft. of elevation reduces sea-level pressure by about 1/10 in. If your barometer cistern were 1,472 ft. above sea level on that June day, your arthmetic would be like this: 1472/106 x 0.1=1.39 in. Adding this to the reading standardized for temperature, 29.43+1.39 =30.82 in. Therefore:

To correct for altitude, divide the elevation in feet by 106 and multiply by 0.1, reading the result as inches and adding to the reading corrected for temperature.

THE extra refinements in scientific barometers, and the extreme care taken in building them, are simply to reduce errors, add to convenience of use, and to increase portability. If you would prefer to make a little more elaborate instrument than the one described, you will find some suggestions in the photographs and drawings on page 331.

In this barometer the upper parts of the guards are replaced with L-shaped ways, so that an indicator can slide upon them. In use this indicator is slid to the approximate position and clamped with the wing screw. Then the cross mark is brought accurately to the mark with a slow-motion screw. A strip of mirror beside the tube reflects the mark and makes the reading doubly accurate.

Instead of depending upon the end of a yardstick to serve as a zero point, another indicator board, also fitted with slow motion, is used. This zero board, which is shown on page 331 in correct relation to the scale rod, is of ¼-in. plywood with a window cut in it to center on the width of the cistern well. It projects ⅛ in. beyond the scale rod so as to run against the scale-rod way. This is to give extra stiffness. Glue a ¼-in. block to the front of the scale rod, and glue and nail the zero board to the back edges of both.

The indicator board, which slides independently at the top of the column, is shown in the lower right-hand corner of the group of drawings on page 331. The opening in the board is rabbeted behind on both sides. The indicator itself is rabbeted at the ends to correspond and slides in the opening. It is held from dropping out of the back by the guides bolted on to clasp the ways. The windows in both indicators may be celluloid or glass with a fine horizontal scratch mark.

For the slow-motion screws, machine screws with small wings soldered in their slots are satisfactory. They can be made to turn without end motion in their bracket by screwing nuts on each side and soldering them.

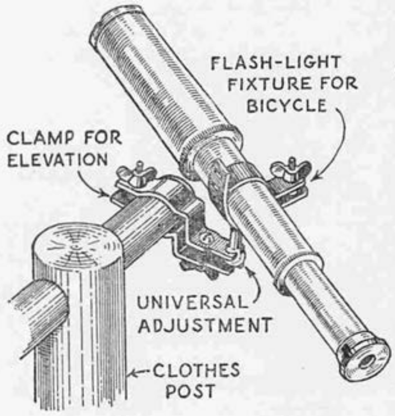
NOTE the indicator board clamp. A small sheet-metal angle is housed within the way, and a 3/16-in. round rod is laid in it. A piece of cold-rolled steel, flush with the rabbet, is then pressed against the ways by the point of a wing screw, which wedges between the side of the angle and the round rod.

A door should be fitted to this barometer case, with a small window to enable the rise or fall of the mercury to be seen.

PREVENTING CRACKS IN CELLULOID WINDOWS

CELLULOID windows in tents, trailer flaps, and car curtains can be preserved with several coats of glue and transparent cellulose wrapping material. Apply a thin coat of clear, transparent marine glue to the clean celluloid and paste a sheet of the cellulose wrapping material smoothly over it. Repeat the process until you have four thicknesses.

CHEAP UNIVERSAL JOINT HOLDS TELESCOPE



Small telescope mounted by means of an inexpensive flash-light clamp sold for bicycles

HOMEMADE contrivances for mounting the small telescopes of amateur astronomers have been made in many degrees of complexity, but for the man who is interested in keeping everything as simple as possible, the best answer will be found in an ordinary bicycle flash-light clamp, which can be purchased for about 35 cents. This fixture is easily attached to the telescope tube, as shown in the drawing, and can be clamped to any convenient pole or other support. The universal adjustment allows the telescope to be trained on any part of the heavens. A clothes-pole will be found to act as a convenient support.

HOT OIL PRESERVES HARDWOOD

A DURABLE, climateproof, antique finish may be given walnut and other hardwoods by pouring boiling-hot linseed oil over the unfinished wood. The surface is then sandpapered or rubbed to a smooth finish, and the process repeated until the wood is as dark as desired. It is then polished with wax.

POCKET CHART AIDS IN LOCAL Weather Forecasting

SUPPOSE vacation time is at hand. The weather is fairly settled, yet it may act up unexpectedly and make us change our plans. Shall we sleep in the open on our trip, or shall we patronize an automobile camp or a hotel? Which will offer the fairest skies, the beach or the mountains?

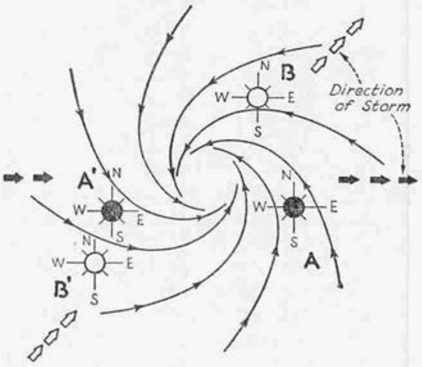
While all sections of the United States are now reached daily by broadcasts of weather information, there is a good deal of satisfaction in reading the face of the sky for yourself, and predicting local weather conditions several hours in advance. If you have a barometer, you can become a skillful prophet by observing that instrument and the wind direction, and by jotting down daily notes on your conclusions. Once in a while you may even make a more accurate forecast than the professionals.

Foul-weather signs naturally result from the build of the storm. When brisk southeasterly winds set in and clouds darken the sky, it is natural to suppose that the threatening storm blew up from the southeast, but this is not the case. It came from the west or northwest, and its center will pass near or north of you, with the wind shifting to northwest by way of south and southwest. If you had noticed, at the beginning of the breeze, that the barometer was falling, you could safely have predicted rain within from twelve to twenty-four hours.

If the wind sets in east to northeast, the storm is coming from the south or southwest, and its center will pass near or to the south, with the wind shifting to northwest by way of north. The rapidity of the storm's approach and its intensity can be judged by the rate and the amount of fall in the barometer.

To visualize the make-up of a storm area—cyclone, weather men call it—suppose that a large airplane propeller mounted horizontally on a rolling carriage is whirling counter clockwise. There is an upward movement of air; and if you should walk around the propeller carrying a vane, you would find that the surrounding air spiraled in toward the center, the direction of the "wind" depending entirely on where you are with relation to the propeller. If the latter were moved from west to east, or from southwest to northeast, while you stood still, the direction of the wind would shift as it does when a storm goes by.

A storm is roughly circular in shape, with a warm, light, moisture-laden core of air rising at the center, and the wind sweeping in spirally from all sides. As the core rises to the thinner upper air it expands; expanding, it cools, just as air from a leaking automobile tire valve rushes out in a cold jet. Before long, the temperature is so low that moisture condenses on the floating dust particles, and clouds are seen. Presently, further expansion loads the damp particles so heavily with water that the upward draft can no longer support them, and they fall as rain. The whole storm system moves across the country at a speed in summer of about 25 M.P.H., and in winter, 35.



As this storm comes from the west, an observer at *A* finds the barometer falling and the wind blowing from the southeast. As its center passes north of him, the wind veers to south, southwest, and west, finally setting in from the northwest as at A^1. Compare the observations at *B* and B^1

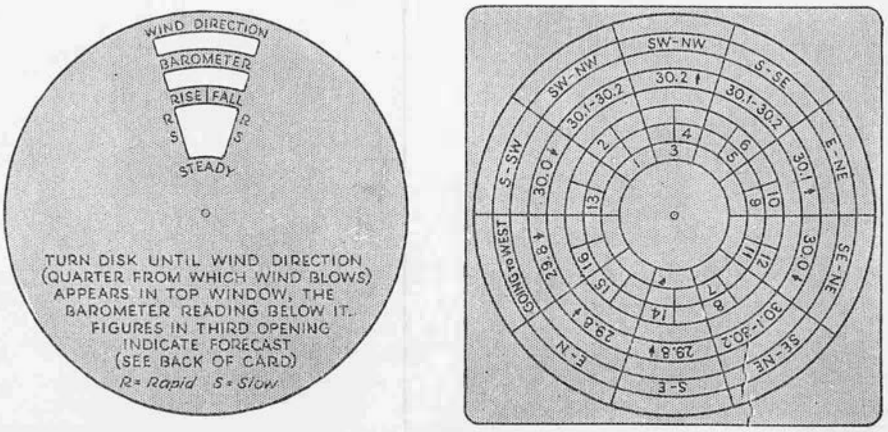
The cool, expanded air, unable to rise higher, and freed of its moisture, is thrust aside by the warmer rising core air and circulates to other localities beyond the storm, where it settles to earth again. This is the reverse of the movement in the storm area, and the winds blow outward from these downward columns in a spiral of clockwise motion. This reverse system, the anticyclone, follows the cyclone, sometimes closely, sometimes at quite a distance.

This explains why air pressure lowers as a storm approaches, and rises again as foul weather recedes and the anticyclone comes along.

The accompanying diagram shows a cyclonic area. Note that an observer at *B*, finding the direction of the wind to be from the northeast, can expect the storm from the southwest, with the wind swinging to north and northwest as the center of the storm passes to the south.

The United States Weather Bureau has worked out some forecasting rules that apply in general to this country, and these are conveniently grouped in the chart on page 85. The assembling of this chart is a simple task that can be done in a few moments of time, and the resulting pocket weather clock is very handy for local forecasting.

Lay out the two dials and paste them on cardboard, trimming the mount to shape when dry. With a sharp-pointed knife, cut out the windows in the front disk, push a pin through the centers for a pivot, and solder behind to a thin metal button. An eyelet or tubular rivet would make a more durable bearing. Paste the forecasts on the back and make a heavy



TURN DISK UNTIL WIND DIRECTION (QUARTER FROM WHICH WIND BLOWS) APPEARS IN TOP WINDOW, THE BAROMETER READING BELOW IT. FIGURES IN THIRD OPENING INDICATE FORECAST (SEE BACK OF CARD)

R= Rapid S= Slow

The two disks can be any convenient size. The author made the outer circle 4 in. in diameter. The key numbers *1* to *16* on the three inner circles refer to the forecasts listed on page 85

FORECASTS

1. Fair, with slight temperature changes, for 1 to 2 days.
2. Fair, followed within 2 days by rain.
3. Continued fair, with no decided temperature change.
4. Slowly rising temperature and fair for 2 days.
5. Rain within 24 hours.
6. Wind increasing in force, with rain within 12 to 24 hours.
7. Rain in 12 to 18 hours.
8. Increasing wind, and rain within 12 hours.
9. In summer, with light winds, rain may not fall for several days. In winter, rain within 24 hours.
10. In summer, rain probable within 12 to 24 hours. In winter, rain or snow, with increasing winds, will often set in when the barometer begins to fall and the wind sets in from the NE.
11. Rain will continue 1 to 2 days.
12. Rain, with high wind, followed, within 36 hours, by clearing, and in winter by colder.
13. Clearing within a few hours, and fair for several days.
14. Severe storm imminent, followed, within 24 hours, by clearing, and in winter, by colder.
15. Severe northeast gale and heavy precipitation; in winter, heavy snow, followed by a cold wave.
16. Clearing and colder.

paper envelope in which to keep the chart.

Take daily readings of the barometer to know whether it is rising or falling, and note in a general way how the wind blows.

To use the chart, turn the disk until the proper wind-direction and barometer indications show in the two upper windows. In the lower window numbers appear. Choose the one suiting the conditions, and read on the back the forecast corresponding to it.

For instance, suppose that the wind sets in between southwest and northwest, and the barometer, rising rapidly, stands between 30.1 and 30.2 in. No. 2 turns up: "Fair, followed within 2 days by rain."

Suppose, again, that the wind is from east to northeast, with the barometer at 30.1 (or above, as indicated by the upward-pointing arrow in the chart), and falling slowly. This reads as No. 9.

By taking daily weather notes you can soon discover the important variations of these rules peculiar to your locality. If you live on the west coast, the meaning of wind and barometer readings will be somewhat different from that of readings taken on plateaus east of the Rocky Mountains. Little rain or snow is to be expected within a low-pressure area over Idaho where the winds, purged of moisture by the mountains, have blown over rather dry areas, although the wind-barometer signs are much the same as those noticed when the storm is west of the Cascades, fresh from a trip over the Pacific Ocean. When this same center of disturbance has moved over the Mississippi Valley, winds laden with moisture from the Great Lakes and the central valleys spiral toward it, and rainfall begins to increase in the eastern side.

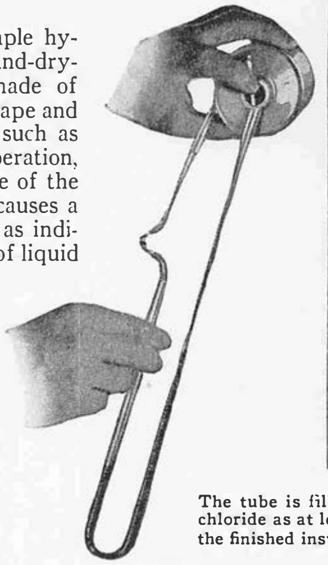
HOLDING PIPE FOR THREADING

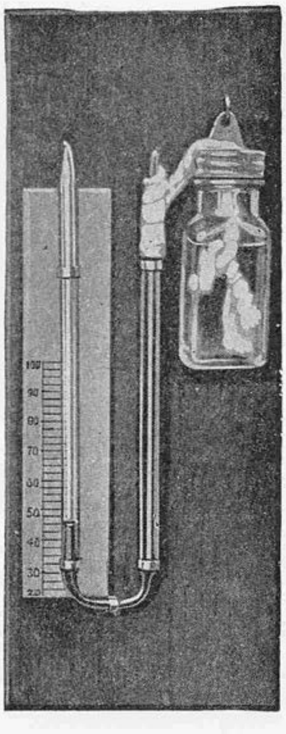
IN THE absence of a pipe vise, a short section of conduit or other pipe can be held for threading by placing it vertically in a machinist's bench vise and catching the pipe with a pipe wrench beneath the jaws of the vise. Tighten the jaws only moderately; the wrench will bear against the vise and prevent the pipe from turning.

SIMPLY MADE

Hygrometer

Gives Direct Moisture Reading





The tube is filled with colored carbon tetrachloride as at left. The height of the liquid in the finished instrument indicates the humidity

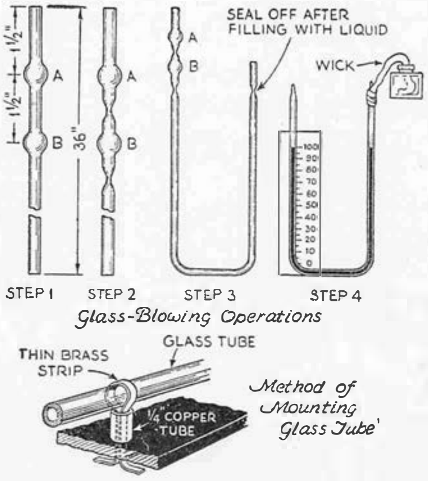
A SENSITIVE yet simple hygrometer of the wet-and-dry-bulb type can be made of glass tubing bent into a U-shape and filled with a volatile liquid such as carbon tetrachloride. In operation, the difference in temperature of the wet bulb and the dry bulb causes a difference in vapor pressure as indicated by the unequal height of liquid in the two arms of the U-tube. The drier the atmosphere, the higher the column of liquid rises in the wet-bulb leg.

Obtain a 3-ft. section of glass tubing having a bore of from 3/16 to ½ in. The smaller sized tubing is easier to handle, and little difference in operation will be noticed. Clean the tube thoroughly and blow two small bulbs 1½ or 2 in. apart and as near one end as convenient. Melt the glass down to about the size of a match between the first and second bulb and also between the bulbs and the long part of the tube. These are to aid later in sealing off the excess air in the tube. Bend the remainder of the tube at the middle so as to form a U-shape with two arms of approximately equal length.

Fill the tube to within an inch or so of the top of the plain arm with carbon tetrachloride colored with a few crystals of iodine.

Seal the top of the plain arm by directing the flame downward. Hold a finger over the open end of the tube and invert the tube to drive out the bubble of air at the closed end. Slowly boil out the liquid until enough is left to fill one arm completely. This can be done either by immersing the tube in a pail of hot water or by direct flame.

While the liquid is slowly boiling up through the capillary tube and the bulbs, melt off the first bulb, being sure not to let any air get back into the U-tube. Chill the second bulb while the U-tube is still warm. This should cause the liquid to condense or boil into the bulb, carrying the last trace of air with it. When this has progressed for a minute or two and some of the liquid has collected in the bulb, seal off this bulb and discard it.



Diagrams of the four chief steps in making the hygrometer, and how the tube is mounted

To test the U-tube for sensitivity, warm the liquid at the surface in one leg by applying the hand. This should force the liquid up into the other, cooler side. A temperature difference of 10 deg. between the two sides of the U-tube should make a change of several inches in the height of the two columns of liquid.

Mount the U-tube with stand-off supports made of ¼-in. copper or fiber tubing cut in ½-in. lengths, with a ⅛-in. brass strip looped through and around the glass as shown. Bring the two ends of the strip through the mounting board and bend the ends flat against the back.

Mount the water reservoir with its mouth about ½ in. from the top of one arm of the U-tube. The wick should cover about 1 in. of the top of the nearer U-tube arm and extend to the bottom of the reservoir. Linen or cotton cloth boiled in sal soda and thoroughly rinsed makes good wicking.

Rule the scale in tenths of an inch on plain white cardboard, with 100 per cent marked at the top. Place the 100 per cent mark behind the dry arm, opposite the point where the two columns of liquid are the same height. With some ⅛-in. brass strips, bend a little collar that will slide up and down the dry arm of the tube to mark the level last observed.

When the water on the wet arm starts to evaporate, it will cool the vapor in the tube and draw the liquid in it up, while the other side goes down. When it is going to rain, evaporation slows down and the two columns of liquid nearly balance.

Appendix and Index

APPENDIX

ONE of the greatest difficulties that besets every amateur craftsman is that of obtaining materials in suitable quantities for home workshop projects. Perhaps more ingenuity has to be exercised in obtaining hard-to-get supplies than in any other part of home craftsmanship.

When the desired materials are not to be purchased at a reasonable price, or cannot be had in small enough quantities, use your ingenuity to find acceptable substitutes. Perhaps a visit to the junk yard will give you just what you want; possibly you can buy an article in the five-and-ten-cent store or in a second-hand shop and take it apart to get the piece you need. A study of the catalogs issued by the large mail-order houses will often reveal materials that can rarely be obtained locally unless you live in a large city.

When all is said and done, however, you will occasionally find it impossible to complete a project for lack of the proper materials. In such cases, there are two services, operated for the benefit of its readers by *Popular Science Monthly* that will be of help to you.

If it is a particular device or piece of material you need, write to the Service Department of *Popular Science Monthly*, inclosing a stamped and self-addressed envelope. A list of dealers or manufacturers of the particular item desired will be sent to you, provided that any promising source of supply can be found through the extensive research facilities of that magazine.

Suppose, however, that you wish to build a project like the model of the privateer *Swallow* that appears on page 91. Such a model calls for numerous pieces of thin wood, wire, sheet metal, chain, cord, and paint, as well as many special fittings such as pulley blocks, deadeyes, and anchors. Even if you live in a big city, it would take hours and hours of shopping to get all these supplies, and the total expense would add up to a sizable sum. For such projects, nothing is better than to be able to buy a complete set of parts in kit form; then you will know that everything is right. Providing kits of this type to its readers at cost is another of the services offered by *Popular Science Monthly*[1]. A list of the outfits available from this source is as follows:

STANDARD SHIP MODEL KITS

A.	Whaling ship *Wanderer*, 20½-in.	$7.40*
D.	Spanish galleon, 24-in.	6.95*
E.	Battleship U.S.S. *Texas*, 3-ft.	7.45*
G.	Elizabethan galleon *Revenge*, 25-in.	7.25*
L.	Farragut's flagship *Hartford*, steam-and-sail sloop-of-war, 33½-in. hull	8.45*
Q.	Privateer *Swallow*, 12½-in. hull	4.95†
V.	Clipper *Sovereign of the Seas*, 20½-in. hull	4.95†
Y.	Trading schooner, 17½-in. hull	4.90†
2S.	U. S. Navy Destroyer *Preston*, 31½-in. hull	5.95*
3S.	*Constitution* ("Old Ironsides"), 21-in. hull	6.50*
4S.	Clipper ship *Great Republic*, 31½-in. hull	8.40*
5S.	Coast Guard patrol boat of new 165-ft. class. Full-hull model, ⅛-in. scale, the hull being 20⅝ in. long	4.95*
6S.	Brig *Malek Adhel*, ¼-in. scale, 20-in. hull, frame-and-plank construction	9.75†
7S.	Brig *Malek Adhel*, as above, but with sawed-out lifts for solid hull construction	9.75*

SIMPLIFIED SHIP MODEL KITS

F.	Liner S.S. *Manhattan*, 12-in.	1.00
H.	Cruiser U.S.S. *Indianapolis*, 12-in.	1.50
J.	Clipper ship *Sea Witch*, 13-in.	1.50

MODEL-OF-THE-MONTH KITS

M.	Aircraft carrier *Saratoga*, 18-in.	$1.00
N.	Four U.S. destroyers, each 6¼-in.	.75
O.	Liner S.S. *St. Louis*, 11-in.	1.00
R.	U. S. cruiser *Tuscaloosa*, 11¾-in.	1.00
U.	*Hispaniola*, the ship in "Treasure Island," 7-in.	.50
Z.	H.M.S. *Bounty*, 11½-in.	1.50
1M.	Show boat, illuminated, 14-in.	1.50
2M.	Ocean freighter, 14-in.	1.50
3M.	Yacht *Nourmahal*, 8⅛-in.	1.00
4M.	Oil tanker, 14-in.	1.50

WHITTLING KITS

No. 7. Whittling kit with two shaped blocks for making sea captain 5½ in. high. A knife, three bottles of paint, pocket sharpening stone, and instructions are included........ 1.50

No. 8. Whittling kit for six different Scotties. Each is 2 by 2¼ in., sawed to shape. Paint, paintbrush, instructions, etc........ 1.00

No. 9. Whittling kit with shaped block for making a sailor 5¼ in. high. Three bottles of paint, a brush, and a sharpening stone are included........ .75

No. 10. Copycraft whittling kit for making one of several Hobo Hank novelties. Contains a master model of tramp's figure, 5¾ in. high, showing every knife cut; also the necessary whittling block, extra wood for making a desk set, pipe rack, or other project; sharpening stone, brush, three bottles of paint........ 1.50

FURNITURE KITS

No. 4. Solid mahogany book trough 22½ in. long, 9½ in. wide, and 24¾ in. high over all. Ready to assemble, with finishes........ 5.30*

No. 5. Solid rock maple hanging wall rack with one drawer, 19½ in. wide, 33¼ in. high. Ready to assemble and stain included........ 5.75*

---

[1] To order any of these kits, address Popular Science Monthly, Dept. AC. 353 Fourth Avenue, New York City. Remittances should be made by money order, check, or registered mail. If you live west of the Mississippi River, or in Canada, add 50 cents to all prices marked with an asterisk (*), and 25 cents to all prices marked with a dagger (†).

THE drawings in this book have been carefully prepared to give the dimensions of the various projects in the clearest, most accurate manner possible within the limitations of the page size. However, many amateur craftsmen prefer to work from large blueprints; indeed in the case of such projects as sail and motor boats, the bigger drawings are almost essential for accurate work, especially to beginners.

To provide its readers with large-size drawings from which to work, *Popular Science Monthly* in 1922 instituted a pioneer blueprint service that has since grown to be by far the greatest of its kind. It is suggested that readers of this cyclopedia can take advantage of the large, clear drawings that this service offers for their workshops at such low cost.

Many of the projects in this book are duplicated in the drawings listed below, and such projects are marked with an asterisk (*). Using the corresponding blueprint in connection with the small drawings and description in this cyclopedia will, of course, make any of these jobs easier to complete.

MODELS

44-45-R. **Barbary Pirate Galley or Felucca**—20 in. long; an excellent model for the beginner, 75c.

46-47. **Spanish Treasure Galleon**—24 in. long, a colorful model; scale of model ⅛ in. = 1 ft.; instruction booklet included, 50c.

Kit of materials with these blueprints, $6.95. (For shipment west of the Mississippi River, add 50c.)

48-R. **20-in. Racing Yacht**—Marconi-rigged sailing model, 50c.

51-52-53-R. **Clipper Ship *Sovereign of the Seas***—20½-in. hull; scale of model 1/12 in. = 1 ft., $1.00.

Kit of materials with these blueprints, $4.95. (For shipment west of the Mississippi River, add 25c.)

57-58-59-R. ***Constitution* ("Old Ironsides")**—21-in. hull; scale of model 1/10 in. = 1 ft., $1.00.

Kit with blueprints, $6.50; west of the Mississippi River, $7.00.

61-62-R. **Viking Ship**—20½ in. long; scale of model ¼ in. = 1 ft., 75c.

63-64-R. **Toy Motorboat**—29 in. long; driven by small electric motor, 75c.

*66. **Ship Model Weather Vane**—Made of wood and metal, 25c.

74-75-76-R. ***Santa Maria***—22½ in. long, $1.00.

83-84-85-R. ***Mayflower***—24 in. long scale of model 3/16 in. = 1 ft., 1.00.

92. **Baltimore Clipper**—8 in. long; sails carved from wood, 25c.

94-95-96-R. **Mississippi Steamboat**—Scale model of the *Buckeye State* (1/12 in. = 1 ft.), 19½ in. long, $1.00.

106-107-R. **42-in. Racing Yacht *Seascout***—A fast Marconi-rigged sailing model, 75c.

108. **Scenic Half-Model of a Barque**—Over-all length of model, 13½ in.; instructions included, 25c.

110-111-112-R. ***Bluenose***—A scale model of a famous record-holding fishing schooner (⅛ in. = 1 ft.), 17½-in. hull, $1.00.

115-116-117-R. **Concord Stagecoach**—Scale model of *Diamond Tally-Ho* (⅛ in. = 1 in.; 20½ in. long). $1.00.

118-119-120-R. **Covered Wagon**—Scale model (⅛ in. = 1 in.; 23½ in. long), $1.00.

121-122. **Clipper Ship in Bottle**—shows how to build a model in a bottle, 50c.

123-124. **Sedan Chair**—Scale model 1/12 in. = 1 in.) of sedan chair used by wife of Louis XV of France, 50c.

125-126-127-R. **U. S. Destroyer *Preston***—31½ in. scale model (1/10 in. = 1 ft.); can be either decorative or working model, $1.00.

Kit with blueprints, $5.95; west of the Mississippi River, $6.45.

138-139-R. **Roman Galley**—19 in. long, a bireme; scale 1/6 in. = 1 ft., 75c.

144-145-146-R. **Cody Coach**—Scale model 5/64 in. = 1 in.; body 13 in. long); of coach said to have once been driven by "Buffalo Bill" Cody; with horses, $1.00.

151-152-153-154. **Whaling Ship *Wanderer*** — A scale model of a famous three masted whaler (1/6 in. = 1 ft.) 20½ in. hull, $1.00. (Sails for *Wanderer* shown on Blueprints 185-186 below.)

Kit of materials with these blueprints, $7.40. (For shipment west of the Mississippi River, add 50c.)

159A. **Racing Yacht *Enterprise***—Hull lines and deck plan for a 30-in. model, 50c.

185-186. **Sails**—Square and fore-and-aft for any model, 50c.

196. **Motorboat**—20-in. hull; a ⅛-in. scale model of the Popular Science Monthly boat *Vagabond;* driven by rubber bands or toy outboard motor, 25c.

197-198-199-200. **U. S. Battleship *Texas***—3-ft. hull; either exhibition or working model, $1.00.

Kit of materials with these blueprints, $7.45. (For shipment west of the Mississippi River, add 50c.)

202-R. ***Miniature Coach and Covered Wagon***—For decorating boxes, etc., 50c.

204. **Liner *Manhattan***—Simple whittled model, 12 in. long, 25c.

Kit with blueprints, $1.00.

206-207-208-209. **Elizabethan Galleon *Revenge***—21-in. hull; 30 in. long and 25 in. high over all, $1.00.

Kit of materials with these blueprints, $7.25. (For shipment west of the Mississippi River, add 50c.)

216. **Cruiser U.S.S. *Indianapolis***—Simple whittled model. 12 in. long, 25c.

Kit with blueprint, $1.50.

219. **Clipper Ship *Sea Witch***—Simplified model, 9½-in. hull, 13-in. long over all, 25c.

Kit with blueprint, $1.50.

221-222-R. **Farragut's Flagship *Hartford***—33½-in. hull. 41 in. long over all, and 25 in. high—two extra-size prints, $1.50.

Kit of materials with these blueprints, $8.45. (For shipment west of the Mississippi River, add 50c.)

225. **Liner *Aquitania***—Simple balsa wood model 9 in. long, 25c.

226-227-R. **Aircraft Carrier *Saratoga* and a Flush-Deck Destroyer**—Balsa wood models 18 in. and 6¼ in. long respectively, 75c.

Kit with blueprint, $1.60.

*228-229-230-R. **Privateer *Swallow***—A Baltimore clipper with 13-in. hull, $1.00.

Kit of materials with these blueprints, $4.95 (For shipment west of the Mississippi River, add 25c.)

231. **Liner *St. Louis***—Balsa wood water-line model 11 in. long, 25c.

Kit with blueprint, $1.00.

233. **Cup Yacht *Rainbow***—Water-line model 7½ in. long on base 5 by 8 in., 25c.

*234. **U.S.S. *Tuscaloosa***—11¾ in. long, 25c.

Kit with blueprint, $1.00.

235. **S.S. *Savannah* and S.S. *Atlantic***—3½ and 6 in. long respectively, 25c.

236. **U.S.S. *Brooklyn***—8 in. long, 25c.

Kit with blueprint, 75c.

237. **"Treasure Island" Ship *Hispaniola***—Balsa wood water-line model 7 in. long, 25c.

Kit with blueprint, 50c.

251. **Liner *California***—Balsa wood water-line model 12½ in. long, 25c.

252-253. **Trading Schooner**—Three-masted with 17½ in. hull, 50c.

Kit of materials with these blueprints, $4.90. (For shipment west of the Mississippi River, add 25 cents.)

254. **H.M.S. *Bounty***—8½-in. hull, 25c.

Kit with blueprint, $1.50.

258. **Civil War Ships *Monitor, Merrimac,* and *Hartford***—Balsa wood water-line models 3½, 5⅜, and 5⅛ in. long respectively, 25c.

263. **Show Boat**—Mississippi River type, 14 in. long, 25c.

Kit with blueprint, $1.50.

264-265. **Liner *Normandie***—20⅝-in. hull, 50c.

271. **Ocean Freighter**—14-in. hull, 25c. Kit with blueprint, $1.50.

272-273-274-R. **Clipper Ship *Great Republic***—31½ in. hull, $1.25.

Kit with blueprints, $8.40; west of the Mississippi River, $8.90.

276. ***Nourmahal***—Power yacht, 8⅛-in. hull, 25c.

Kit with blueprint, $1.00.

283. **Liner *Queen Mary***—10¼-in. hull, 25c.

284. **Tugboat, Harbor**—Full-hull model 11⅜ in. long, 25c.

285. **Harbor Tugboat and Barge**—Miniature water-line models 5 3/16 and 7 3/16 in. respectively, 25c.

286-287-R. **Coast Guard Patrol of 165-Ft. Type**—20⅝ in. hull, 75c.

Kit of materials with blueprints, $4.95; west of the Mississippi River, $5.45.

*292A-293A. **Gettysburg Cannon**—11⅝ in. long; scale 3/32 in. equals 1 ft., 75c.

294. **Oil Tanker**—14 in. long, 25c.

Kit of materials with blueprint, $1.50.

298A. **Barnegat Lighthouse**—10½ in. high, 25c.

304-305-306. **Brig *Malek Adhel***—20-in. hull; frame-and-plank construction; ¼-in. scale, $1.00.

Kit of materials, frame-and-plank construction, with blueprints, $9.75; west of the Mississippi River, $10.00. Kit with sawed-out lifts for solid hull construction, $9.75; west of the Mississippi River, $10.25.

FURNITURE

1. **Sewing Table**—16 by 20 in. top with drop leaves (no turning), 25c.

2. **Smoking Cabinet**—2 ft. 4 in. high, four legs (no turning), 25c.

5. **Kitchen Cabinet**—24 in. by 4 ft. wide by 5 ft. 8 in., folding seat (no turning), 25c.

11. **Combination Bench and Tilt-Top Table**—Back of bench folds down to form table top (no turning), 25c.

13. **Tea Wagon**—Has removable tray and drop leaves; 20 by 30 in. top (turning), 25c.

17. **Cedar Chest**—Mahogany trimmed; 19 in. wide, 3 ft. 4 in. long, and 22 in high (no turning), 25c.

18. **Telephone Table and Stool**—Has bench that fits under table; 17 by 21 in. top (no turning), 25c.

19. **Grandfather Clock**—Straight sides, 29 in. wide, 15 in. deep and 7 ft. 6½ in. high, 25c.

20. **Flat Top Desk**—2 ft. 2 in. by 4 ft. 2 in. top (no turning), 25c.

21. **Colonial Writing Desk**—Governor Winthrop style; 3 ft. 6 in. high and 3 ft. 8 in. long (no turning), 25c.

24. **Gate Leg Table**—3 ft. 6 in. diameter, circular top with leaves up (no turning), 25c.

27. **Kitchen Table Cabinet**—27 by 48 in. top; has folding seat (no turning), 25c.

31. **Two Sewing Cabinets**—Priscilla (turning) and Modern (turning optional), 25c.

49. **Broom Cabinet**—24 in. wide, 17 in. deep, and 5 ft. 10 in. high (no turning), 25c.

60. **Welsh Dresser**—6 ft. high (no turning), 25c.

68. **Magazine End Table and Book-Trough Reading Table**—Two designs for small reading tables (no turning), 25c.

70-71. **Console Radio Cabinet**—16¾ in. deep, 34½ in. long and 38⅝ in. high (no turning), 50c.

77. **Pier Cabinet**—Hanging Bookshelves and Corner Shelves (no turning), 25c.

78. **Treasure Chests**—With metal bindings (no turning), 25c.

88. **Modernistic Stand and Bookcase** — Stand, 24⅜ in. high; bookcase, 70½ in. high (no turning), 25c.

91. **Modernistic Folding Screens**—Four designs (no turning), 25c.

93. **Modernistic Lamps**—Three designs (no turning), 25c.

100. **Modernistic Book Ends**—Bookshelf and Low Stand (no turning), 25c.

105. **Tavern Table and Scroll Mirror**—Shows full size outline of scroll (table has turning), 25c.

140. **Tilt-Top Table**—Oak, top 20 by 24 in., instruction booklet included (turning), 25c.

178A. **Sewing Cabinet of 1812,** 50c.

179A. **Child's Costumer,** 25c.

187A-188A. **Fireside Bench.** Colonial, maple, 50c.

*189A. **Drafting Table,** 25c.

191A. **Early American Round-Top Stand,** 50c.

*238A. **Smoking Stand,** Modern, 25c.

239A. **Four-Leaf Card or Occasional Table,** 25c.

240A. **Upholstered Stool,** 25c.

241A. **End Table,** American Empire, 25c.

242A. **Scoop-Seat Stool,** 25c.

243A. **Floor Lamp with Tripod Base,** 25c.

245A. **Coffee Table with Spiral Legs,** 25c.

246A. **Mirror Frame,** 20 by 30 in., 25c.

*249A. **Tile-Top Tables** (wood and metal), 25c.

*250A. **Magazine Rack,** Ladder-Back Style, 25c.

256A. **Silverware Chest on Stand,** 25c.

266A. **Fireside Seats**—One wood and one metal design, both with fiber seating, 25c.

*277A. **Double-Decker Bed and Hunting Knife,** 25c.

278A. **Radiator Inclosures and Scroll Candelabra,** 25c.

*280A. **Hanging Wall Cabinet and Nautical Porch Lamp**—Cabinet is 9½ by 24 by 41¾ in. and Colonial in design, 25c.

*290A **Spool-Turned Table** (22 by 28-in. top) **and Ball-Bearing Reels for Kite Flying or Trolling,** 25c.

295A. **Queen Anne Dressing Table, Stool, and Mirror,** 75c.

296A. **Magazine Rack and Wooden Wastebasket to Match,** 25c.

308A. **Small Early Colonial Pine Chest**—32 in. long, 21 in. deep, 24 in. high, 25c.

312A. **Portable Tea Wagon and Cabinet into Which it Rolls,** 25c.

317A. **Flowerpot Stand** (38½ in. high) **and Novel Modern Lamp,** 25c.

318A. **Maple Tavern or Long Table, Colonial** (top 30 by 68 in.), 50c.

RADIO SETS

42. **Three-Stage Amplifier**—Audio-frequency, battery operated, 25c.

103. **One-Tube Receiver**—Battery operated, 25c.

109. **Screen Grid Receiver**—A good distance getter, 25c.

130. **Full Electric Headphone Receiver**—Can be made compact for portable use, 25c.

137. **Short Wave Converter**—Full electric unit that allows short wave reception with high-grade broadcast receiver; attaches to antenna post of receiver. 25c.

155. **Amateur Short Wave Receiver**—3 tubes, battery or 110-volt A.C. or D.C. operation, 25c.

183-184. **Amateur Continuous Wave Transmitter**—2 tubes, either 171A, 245, or 210, 50c.

217-R. **All-Wave Portable Receiver**—2 tubes, battery operated, 50c.

223. **Five-Tube Short-Wave Set**—Midget receiver with loudspeaker, A.C. or D.C., 25c.

BOATS

25. **Sailing Outfit for Canoe**—Lateen sail, 25c.

131-132-133R. **Combination Boat**—A 15-ft. hull that can be powered by sail, outboard motor, or oars, $1.00.

133A. **Marconi Rig** for above boat. 25c.

147R. **13-ft. Motorboat-Rowboat**—A decked hull for use with outboard or inboard drives and oars, 50c.

148-R. **14½-ft. Motorboat-Rowboat,** 50c.

149-R. **16-ft. Motorboat-Rowboat,** 50c.

150. **Stern Drive Installation**—Shows how to use the new stern inboard drive in Motorboat-Rowboat or Runabout, 25c.

170-R. **Folding Duck Boat**—13 ft. long; can be rowed, paddled, or sailed with canoe sail (folding feature can be omitted), 50c.

175-176-177-R. **Runabout (Sportboat)**—15½ ft. long with detachable top, seats that fold into bunks, etc.; for use with outboard or inboard drives, $1.00.

192-193-194-R. **Canoe** — 16-ft. canvas covered kayak with sail, etc., $1.00.

161A. **Ice Scooter**—A new type of racing ice boat; has hull like boat, 50c.

*211-212-R. **Outboard Racer**—Streamlined hydroplane, 10 ft. 4 in. long, 114 lb., for class "A" and "B" motors, 75c.

*224-R. **Utility Rowboat**—13 ft. long; can also be sailed or driven by outboard motor, 50c.

257-R. **High Speed Boat for Small Outboard Motors**—7 ft. 11 in. long, 46¾ in. beam, 50c.

261-262-R. **Racing Runabout**—13 ft. stepless hydroplane for outboard motor, 75c.

*270. **Inboard Motor Installation**—Shows how to fit inboards to the Popular Science Monthly runabout, motorboat-rowboat, or any small boat, 25c.

279-R. **Canvas-Covered Duck Boat**—13 ft. 6 in. long, 50c.

281-R. **Camper's Utility Boat**—11 ft. 2 in. long, canvas-covered, for outboard motor or rowing, 50c.

309-310. **Sport Runabout**—9 ft. 8 in. long, 43-in. beam, for small outboard motors, 50c.

314-R. **Sailboat**—12 ft. long, weighs 200 lb.; has fast skimming-dish hull, 50c.

321-322-323. **Racing Sailboat** *Blackcat,* 13 ft. 4 in. long, 5 ft. beam, weighs 250 lb., Marconi rigged, 75c.

AIRPLANE MODELS

50. **Rise-off-Ground Tractor**—3-ft. wing spread, 25c.

82. **Single Stick**—Simple model having 30-in. wing spread, 25c.

86. **Twin Pusher**—35-in. wing spread racing model, 25c.

87. **Seaplane**—Tractor model having 30-in. wing spread, 25c.

102. **Twin Pusher Seaplane**—29¼-in. wing spread model of a famous record breaker (12½ min.), 25c.

104. **Tractor**—36-in. wing spread, record flight of 6,024 ft., 25c.

135-136. **20-in-1 Combination**—Twenty planes can be assembled from ten simple parts; 20-in. wing spread, 50c.

141-142-143. ***Winnie Mae***—4 ft. wing spread flying scale model of Post and Gatty's round-the-world Lockheed plane, instruction booklet included, 75c.

162A. **Curtiss *Robin***—Whittled scale model, non-flying; 15¼-in. wing, 25c.

163A. **Flying Boat *DO-X***—A whittled scale model of this famous passenger plane; 36-in. wing, 25c.

164A. **Curtiss Hawk**—A whittled scale model of an Army plane; 16-in. wing, 25c.

165A. **Travel Air Mystery Ship**—A whittled scale model of a low-winged monoplane; 12-in. wing, 25c.

166A. **Fokker *D-7***—A whittled model of one of Germany's World War fighting planes; 13½-in. wing, 25c.

168-169. **S. E. 5a World War Plane**—30-in. flying model with instructions, 50c.

190A. **Autogiro** — Whittled model, 8 in. long, 11½-in. wing, 50c.

205A. **Gee Bee Sportster**—Whittled scale model, wing spread 8¼-in., 25c.

210A. **Fairchild Cabin Monoplane** — Whittled model, 15-in. wing, 25c.

213A. **Captain Mollison's Transatlantic Monoplane *The Heart's Content***—Whittled model, 12¾-in. wing, 25c.

215A. **Laird Super-Solution Biplane** — Whittled model, 9-in. wing, 25c.

218A. **Boeing Transport**—Whittled model, 27¾-in. wing, 25c.

TOYS

14. **Electric Train, Horse, and Doll's House**—All three projects on one blueprint, 25c.

56. **Birds and Animals**—Patterns for cutting with fret saw, 25c.

67. ***Spirit of St. Louis***—A toy model of Lindbergh's famous New York-to-Paris plane, 25c.

72. **Colonial Design Doll's House**—28 in. by 34 in. by 32 in. high, 25c.

73. **Doll's House Furniture**—Includes chairs, tables, couch, bed, grandfather's clocks, bathtub, basin, shutters, dressing table, stool, books, and bench, 25c.

101. **Fire Engine, Sprinkler, Dump Truck and Tractor**—Made mainly from scrap materials, 25c.

113. **Lathe, Drill Press, Saw and Jointer**—Small motor-driven toys that work, 25c.

114. **Airplane Cockpit with Controls**—An airplane cockpit fitted with regular controls that move a small model plane mounted on the cockpit cowling, 25c.

MISCELLANEOUS

9. **Arbor with Two Seats and Garden Gate**—A combination that resembles a small garden house, 25.

10. **Porch Swing**—A 4-ft. seat suspended by chains, 25c.

26. **Baby's Crib and Play Pen**—2 ft. 2 in. by 4 ft. by 2 ft. 1 in. high; screening on sides and top; top folds back, 25c.

34. **Garden Trellises**—Four trellises and one sundial post, 25c.

65. **Six Simple Block Puzzles,** 25c.

156A. **Rustic Settee** — Garden bench made of rough lumber with bark left on, 25c.

160A. **Model of Old *Fort Union***—A model of a famous western trading post, 50c.

214. **Perpetual Star Chart,** 25c.

220. **Microscope Kit, Portable**—A boxlike container with drawers for holding all equipment, 25c.

244A. **Bird House, Log-Cabin,** 25c.

247A. **Tie Rack, Extension Book Rack, and Turned Box,** 25c.

*248A. **Acrobatic Monkeys Toy, One-Legged Table, and Hat and Coat Rack,** 25c.

255A. **Automatic Lighthouse Night Lamp and Pelican Design Sewing Kit,** 25c.

*259A. **Projector for Photos and Pictures,** 25c.

260A. **Garden Chair,** 25c.

267A. **Knitting Bag with Wooden Frame, Book Ends, and Collar Holder or Clip,** 25c.

268A-269A. **Four-Treadle Hand Loom**—Weaves fabric 38 in. wide, 75c.

275. **Turned Costume Jewelry and Solid Model of Argonaut Pirate Flying Boat,** 25c.

277A. **Hunting Knife and Double-Decker Bed,** 25c.

278A. **Scroll Candelabra and Radiator Inclosures,** 25c.

280A. **Nautical Porch Lamp and Hanging Wall Cabinet,** 25c.

*282A. **Modernistic Desk Clock and Information on Cutting and Etching Metal with Acid,** 25c.

*288A. **Picture Frames, Wooden, and Bud Vase Holder of Metal and Glass,** 25c.

289A. **Turned Stand for Flower or Fruit Bowl and Information on Making Name Stamps from Glue,** 25c.

*290A. **Ball-Bearing Reels for Kite Flying or Trolling and a Spool-Turned Table,** 25c.

*291A. **Sundial, Metal with Concrete Pedestal, and Method of Laying Out a Dial for Any Latitude,** 25c.

297A. **Wood Mosaic Serving Tray and Novelty Wooden Book Ends,** 25c.

298A. **Simple Jewelry Designs and Barnegat Lighthouse Model,** 25c.

299A. **Cigarette Holder**—Designed in form of miniature three-gun naval turret, 25c.

300-301-R. **Outdoorsman's Lightweight Trailer** (10-ft. long. 4 ft. wide, 4 ft. 9 in. high; kitchenette on back, 75c.

302A. **Electric Teacher or Question-and-Answer Game**—with Queen Anne stool on same sheet, 25c.

*303A. **Mail Box with Buzzer, Toy Target, and Modern Scroll-Type Metal Book Ends,** 25c.

307A. **Turned and Inlaid Buffet Set**—A Bowl and pair of candlesticks, 25c.

315A. **Ski Spreader and Clamps, and Method of Making Oval Picture Frames,** 25c.

***Photographic Enlarging Outfit** (leaflet only), 10c.

Resilvering Mirrors at Home (leaflet only), 10c.

***Workbenches and Tool Cabinets**—fifteen designs (leaflet only), 10c.

NOTE: To order these blueprints, address *Blueprint Service Department, Popular Science Monthly,* 353 Fourth Avenue, New York City. The blueprints, in most cases, are printed on 15 by 22 in. sheets. In ordering it is necessary to give only the blueprint numbers. When there are two or more numbers followed by a single title, it means that there are two or more blueprints in the complete set. If the letter "R" follows a number it indicates that the blueprint or set of blueprints is accompanied by a special reprint of the magazine article or articles which appeared at the time the project was first published. If you do not wish this reprint, omit the letter "R" from your order and deduct 25 cents from the price given. Reprints alone are sold for 25 cents each.

AS THE owner of this cyclopedia becomes especially interested in one or two of the many hobbies included within its pages, it is natural for him to seek more information on the particular subjects that interest him. To put all the essential information on the topics in which its readers have shown the most interest in compact, readable form, *Popular Science Monthly* has prepared the library of low-priced manuals listed below. Each book is distinctive and complete in its own field, and is illustrated with numerous diagrams that make it easy to become expert in the hobbies you have chosen.

WOOD CARVING AND WHITTLING—265 pages, full cloth bound, $2.00

DECORATIVE METAL WORK—Full cloth bound, completely illustrated, $2.00

RADIO EXPERIMENTER AND BUILDER—256 pages, full cloth bound, $2.00

AUTO KINKS—Fully illustrated, cloth bound, $1.00

THE HOME CHEMIST—Many diagrams and illustrations, full cloth bound, $1.00

WONDERS THROUGH THE MICROSCOPE—192 pages, numerous illustrations, cloth bound, $1.00

MAKING MONEY WITH YOUR CAMERA—Cloth bound, 256 pages, $2.00

HOW TO BUILD CABINS, LODGES, BUNGALOWS—Illustrated with plans and diagrams. Full cloth bound, 256 pages, $2.00

MANUAL OF SHIP MODEL MAKING—Almost 100 illustrations, 192 pages, full cloth bound, $1.00

FIX IT YOURSELF—256 pages, fully illustrated, cloth bound, $1.00

ASTRONOMY FOR AMATEURS—Many illustrations, full cloth bound, $1.00

WOODWORKER'S TURNING AND JOINING MANUAL—192 pages, many illustrations, full cloth bound, $1.00

MODEL RAILWAYS—256 pages, full cloth bound, many illustrations, $2.00

ELECTROPLATING—Pictures, diagrams, formulas, 260 pages, full cloth bound, $2.00

BOOK OF FORMULAS—250 pages, cloth bound, $1.00

A B C's OF DIESEL ENGINES—Full cloth bound. 320 pages, 21 chapters, useful tables and reference data, fully illustrated, $3.00

INDEX

Acetylene torch, 241
Aerocar, toy, 39
Air compressor, made from refrigerator unit, 252
Air compressor, workshop, 251
Airplane, game, 39
  indoor model, 114
  thermal-hunter, model, 111
  ticket-dropping, 33
  toy, 39
Alphabet, jig-sawed, 139
Aluminum paint, sprayed on Christmas tree, 214
Aluminum, working, 291
Ammonia, finishing copper with, 230
Amplifier, radio, 293
Anemometer. 320
Aquaplane, hollow, 55
Aquarium forms model display case, 113
Aquarium, illuminated, 154
Arc furnace, 255
Archery, bow, 49
  targets, 76
Arctic bronco, 86
Arc welder, 307
Arm-chair radio set, 294
Artificial marble, 19
Ash tray, made from bottle, 22
Ash trays, metal, 228
Auger bits, rack for, 241
Auto-driving game, 31

Back pack, lightweight, 81
Baked-on enamel, 190
Baker, reflection, 65
Balls, wooden, turning, 142
Bamboo, keeps curtain closed, 214
Band saws, setting, 249
Banjo clock, electric, 132
Bank, penny, 40
Bar clamp, used in drilling, 117
Bar pin, leather, 26
Barometer, mercury, 330
Bars, straightening, 237
Baseboard, fastening wires to, 208
Basket, flower, 202
  lead, 230
Basket platform for clothes drier, 214
Beach umbrella, improving, 82
Bed slat, nail holds, 193
Bench, garden, concrete, 196
Benches, workshop, 253
Bench legs, from pipe, 248
Bending jig, for vise, 254
Bevel square, take-down, 258
Bicycle stand, spring for, 30
Bird bath, concrete, 196
Bird, comical coconut, 28
Bird houses, 203
Birthday-candle holder, 158
Blinds, Venetian, 201
Block, sanding, 258
Blocks, mystifying, jig-sawed, 261
Blowpipe, 259
Blue, for metal parts, 222
Blueprints, making, 236
Boat, boy's, 59
  handy rope for, 64
  installing motors in, 70
  racing runabout, 60
  sail slides and track, 80
  tiller, hooking up, 88
  utility rowboat, 66
Bobsled, building, 87
Boiler, cleaning, 250
  for model steam engine, 108
Bolt, held by screwdriver, 131
Bonbon dish, copper, 226
Book ends, cat-and-dog, 138
  linoleum-block, 22
  tree-stump, 140
  turned rosette, 153
Bookshelf, antique, jig-sawed, 131
Bottle, growing plant in, 202
Bottles, cutting jig for, 259
  making novelties from, 22
Boy's boat, 59
  room, furnishings, 35
Bow, American flat, 49
Bowls, plating, 180
  holder for, 144
Box, jewel, resembles book, 128
  printing, photographic, 269
  veneered, 123
Bracelet, leather, 26
Braces, made from conduit, 65
Brads, spring holder for, 266
Brushes, lacquer, cleaning, 184
  made from broom, 256
Brush keepers, 174
Brush wiper, 180
Bud-vase holder, 227
Buffing wheel, sharpening with, 166
Built-in furniture, doors for, 172
Butterfly drop-leaf table, 164
Buttons, made from nuts, 122
Buzzer, automatic, for mail box, 215

Cabinet, colonial corner, 161
  dish-drying, 205
  doors, 206
  made from sewing-machine, 160
  made into end table, 134
  sportsman's, 52
  tool, recessed, 244
Cabinets, aluminum, making, 291
  tool, 244, 249
Cake stand, folding, 170
Calendar, perpetual, 145
Calendar and pad holder, 26
Calfskin, model lifeboat covers, 117
Camera, enlarging, 277
  neck strap, 276
  lens hood, 272
  pinhole, 275
  tripod, 271
Camp fires, kindling, 101
Camp table and chairs, 74
Candle holders, Christmas, 141
  for birthday cake, 158
  modernistic, 226
Candlelight, made from bottle, 22
Candlestick, forged, 229
Candy-pail holder for hose, 208
Cannon, Gettysburg, model, 118
Carrier for boats, 59
Carrousel, child's, 38
Carrying case, leather, 23
Carved wooden fruit dish, 128
Carving with jig-saw and sander, 127
Carvings, smoothing, 101
Casements, steel, screens for, 215
Casting, plaster ornaments, 27
  rod, angler's, 73
Cast resins, working, 11
Cat-and-dog book ends, 138
Cattle guard, model railway, 109
Cellar walls, damp-proofing, 176
Celluloid, bending, 10
  cementing, 10
  preventing cracks in, 332
  working, 9, 10
Cellulose tape, jewelry made from, 16
Cellulose ribbon, hides plywood edges, 188
Cement, for sanding disk, 236
  mixing, 195, 196
Centering device, drill press, 246
Chain, whittling, 146
Chairs, camp, 74
Chair, Chippendale wing, 148
Chalk, using for layout work, 182
Chemicals, keeping dry, 248
Children's cottage, 197
Chimes, electric, 283
Chinese lamp, 134
Chippendale wing chair, 148
Chisels, sharpening, 166
Christmas candle holders, 141
  lighting, 212
  star, 25
  tree, spraying, 214
Chuck, lathe, reversing jaws, 268
Cigarette box, made from bottle, 22
  holder, jig-sawed, 21
  server, 229
Cigarette tin, keeping sandpaper in, 242
  used to hold tap and dies, 252
Cigarettes used for measuring, 134
Circus dog, toy, 38
Clamping joints with webbing, 146
Clamps, made from inner tubes, 58
Clip, for hanging magazine, 268
Clock, banjo, electric, 132
  darkroom, making, 281
Clothes dryer, basket platform, 214
Coaster wheels, from ball bearings, 32
Coating metal with solder, 284
Coconut, comical bird made from, 28
Coffee can, toys made from, 48
Coffee table, 167
Colonial corner cabinet, 161
  cricket with rockers, 166
  drop-leaf table, 164
  lantern, copper, 228
Coloring ship models, 185
Compresser, workshop, 251
Concrete bench, 196
  birdbath, 196
  fence posts, 195, 196
  flagstones, 196
  flower pots, 196
  mixer, 194
Conduit, electric, used for braces, 65
Copper, finishing with ammonia, 230
Corner cabinet, colonial, 161
Corner joints in thin stock, 263
Cottage, fairy-tale, children's, 197
Cotter pin, safety pin serves as, 122
Couch, studio, made from davenport, 208
  with inner-tube springs, 147
Coupler, model-railway, magnetic, 110
Crib, folding, 40
Cricket, colonial, with rockers, 166
Cross feed for lathes, geared, 260
Cross hairs, telescope, 328
Crossings, model railway, 109
Crystallized lamps, 328
Cupboard doors, making, 206
Current for electroplating, 302
Curtain rods, inserting, 166
Curve-cutting jig, 261

Cushions, overstuffed, repairing, 159
Cutting sheet metal with acid, 219

Damp-proofing cellar walls, 176
Darkroom, clock for, 281
  fitting up, 273
  portable, 274
Davenport, made into studio couch, 208
Decorating metal, hammers for, 227
Decoys, silhouette, 77
Demagnetizing tools and watches, 284
Designs, tin-foil, 222
Desk, slant-top, 157
Dippers, tin-can, for paint, 184
Dish-drying cabinet, 205
Dish, bonbon, copper, 226
  fruit, carved wood, 128
Disk, sanding, cement for, 236
Display case, model 113
Diver, toy, 39
Dividers, proportional, 241
  used to mark planks on models, 258
Dog, circus, toy, 38
  houses 211
  leash, square-knot, 15
Doll furniture, 37
Doors, cabinet and cupboard, 206
  for built-in-furniture, 172
Dowels, made with pipe, 256
Drafting table 150
Drawers, hardware, 262
Dressing mirror, 151
Drill, bar clamp applies pressure to, 117
Drilling glass, 237
Drill press, centering device for, 246
  model maker's, 245
  vises for, 252
Drop-leaf table, colonial, 164
Dust-removing system, vacuum, 231
Dye, wood, made from photo colors, 104

Earthquake recorder 326
Easel, portable, 256
Easter-egg holder, jig-sawed, 138
Electric banjo clock 132
  chimes, 283
  eye, 286
  furnace, 267
  motor, made from auto cut-out, 117
  outboard motor, 54
  pencil, 308
  thermometer, 306
Electromagnets, 290
Electroplating, current for, 302
  on wood, 300
Emery cloth, holding in vise, 261
Enamel, baking, 190
Enameling, 183
Endless chain, whittling, 146
Enlargements, focusing, 248
Enlarging camera, 277
Enlarging paper, box for, 272
Entrance, cutting in house, 218
Equatorial telescope, 312
Eraser, polishing with, 248
Etching name plates, 230
Experiments with neon tubes, 285
Eyepiece turret, telescope, 315

Fence, garden, concrete posts, 195
Fences, designs for, 210
Fillers using, 177
Film, hangers for, 282
  for focusing enlargements, 248
Filters, color, for microscope, 280
  photographic, 276
Finishing furniture, 173
Fireplaces, outdoor, 191
Fishing waders, 80
Fixing loose screws, 290
Flagstones, concrete, 196
Flash-light reflector, refinishing, 290
Flasher signal, model-railway, 110
Flower basket, lead, 230
Flower pot, concrete, 196
Flower stand, twisted, 156
Flying-ball game, 29
Focusing enlargements, 248
Folding crib, 40
Forecasting weather, 333
Forged candlestick, 229
Frames, picture, 137
French polish, for turnings, 188
Fruit dish, carved wooden, 128
Furnace, arc, 255
  electric, 267
  gas, 243
  heat-control system, 216
  thermostats, adjusting, 194
Furniture, boy's room, 35
  built-in, doors for, 172
  finishing, 173
  garden, 204
  upholstering, 150
  varnishing, 179

Games, 29, 31, 39
Garden, concrete-post fence, 195
  furniture, 204
  gates, ornamental, 198
  pool, rustic, 197
  trellises 200
Gas furnace, 243
Gates, garden, ornamental, 198
Gauge, wind, 320
Gettysburg cannon, model, 118
Geared cross feed, lathe, 260
Gears, cutting on lathe, 242
Ginger jars, finishing, 187
Glass cutter, used to cut masks, 254
Glass, cutting, 69
  jig for, 259
Glass, drilling, 237
Glazing putty, uses for, 176
Glider, porch, 199
Globe, geographical, mounted under lamp, 125
Gluing paddles, 54
Gold, testing, 228
Golf-ball pool table, 48
Graphite, shop uses for, 117
Grease gun, unscrewing, 258
Grinder, folding mount for, 266
Guide, tap, 250, 256
  weather, 319

Hack saw, power, 254
Hammers, for decorating metal, 227
Handles, animal, for trays, 129
Hand-wrought hardware, 221
Hangers, film, 282
Hardware, drawers, 262
  hand-wrought, 221
Hardwood, preserving, 332
Heat-control system, 216
Hinged stencil, 190
Holder, bud-vase, 227
  candle, modernistic, 226
  for shallow bowls 144
Hook, for knot work, 10
Hose, candy-pail holder for, 208
  making from inner tube, 85
Hot oil preserves hardwood, 332
House, cutting entrance in, 218
Houses, dog, 211
  bird, 203
Hunting knife, 85
Humidity, test for, 311
Hygrometer, 334

Ice yacht, full-vision, 86
Illuminated aquarium, 154
Ink for writing on metal, 160
Inlaid names in wood, 125
Inlaid-wood pictures, 121
Inner tubes, kneeling pads from, 205
  used as clamps, 58
Inner tube-springs for couch, 147

Jewel box resembles book, 128
Jewelry, made from cellulose tape, 16
Jig, curve and taper-cutting, 261
  mortising, 257
  glass-cutting, 259
Jig-sawed alphabet, 139
  bookshelf, antique, 131
  bunnies hold easter eggs, 138
Jig-saw carving, 127
Jig-saw, mystifying blocks cut on, 261
Joints, corner, 263

Keepers, brush, 174
Keeping chemicals dry, 248
Key-case snap, repairing, 260
Kindling camp fires, 101
Kites, 89
Kneeling pads, 205
Knife, hunting, 85
Knives, magic, 41
  paper, 224
Knot work, 15, 17
  special hook for, 10

Ladder-back magazine rack, 160
Lamp, Chinese, 134
  in form of tree, 124
  nautical, 133
  of seven shapes, 143
  porch, 224
  with geographical globe, 125
  with secret compartment, 136
Lamps, crystallized, 328
Lantern, colonial, copper 228
  salad-jar, 230
  wall, 40
Latitude, finding, 309
Lathe, chuck, reversing jaws, 268
  cutting gears in, 242
  geared cross feed, 260
  hints for machinists, 268
  moldings made on, 144
  radius-turning tool, 266
  using hand drill for, 109
Laying out sundial, 329
  workshop, 247
Layout work, chalk for, 182
Lead, acid tray covered with, 256
  flower basket, 230
  smoker's set, 228
Leak, stuffing box, 82
  leather, working, 26
Legs, bench, 248
Lens hood, camera, 272
Letter, enclosing stamps in, 259
Letters, celluloid, 18
Lifeboat covers, model, 117
Lifting stunts, 290
Lighting, Christmas, 212
  shop, tests for, 234
Linoleum-block book ends, 22
Love seat, maple, 169
Lubricant, graphite, 117
  greaseless pencil 292
Luggage making, 23

Machine, saw-setting, 249
Magazine, hanging, 268

Magazine rack, ladder-back, 160
Magnets, electro-, 290
Magic knives, 41
Mail box, 215
Marble, artificial, 19
Masks, printing, 254
Mayan throwing sticks 53
Measurements, star, 314
Measuring, with cigarettes, 134
  split-hundredths, 246
Mechanical stage, microscope, 318
Mercury barometer, 330
Merry-go-round, child's, 38
Metal, blue for, 222
  decorating, hammers for, 227
  plating on wood, 300
  tubing, ornamenting, 223, 225
  typewriting on 301
  writing on, 160, 308
Microfilm-covered airplane model, 114
Micrometer, adjusts watch, 241
Microscope, color filters, 280
  mechanical stage, 318
  photomicrographs made without, 279
  transparent cover, 328
  uses in shop, 238
Miniature liners, constructing, 120
Mirror, dressing, 151
Mixer, concrete, 194
Model maker's drill press, 245
  paints, keeping, 190
Models, airplane, indoor tractor 114
  airplane, thermal hunter, 111
  Baltimore clipper, 91
  battle cruiser *Tuscaloosa,* 105
  display case, 113
  Gettysburg cannon, 118
  lifeboat covers, 117
  liners, 120
  marking planks, 258
  railway, magnetic coupler, 110
  railway, crossings and signs, 109
  railway, flasher signal, 110
  railway, telltales, 101
  turnbuckles, 117
  sails, 186
  steam engine, 106
  yacht, testing alignment, 101
Moldings, made on lathe, 144
  picture frame, 135
Monkeys, wooden, 32
Mortising jig, 257
Motor boat, trolling disk, 79
Motor, electric, from auto-cut-out, 117
  shop, from vacuum cleaner, 256
Motors, installing in boat, 70
  outboard, pepping up, 71
Mount, folding, for grinder, 266
Mystifying blocks cut on jig-saw, 261

Nail hole, concealing, 178
Nail polish, as cement, 10
Nails, fastening in plaster, 205
Name plates, etching, 230
Navigation, 309
Neck strap, camera, 276
Neon tubes, 285
Nest of tables, 171
New uses for old cabinets, 134, 160
Newspaper rack, 136
Novelties for snow and ice, 86
Nuts, buttons made from, 122

Oil can, made into blowpipe, 259
Ornamenting metal tubing, 223, 225
Outdoor fireplaces, 191
Outboard motor, electric, 54
  pepping up, 71
Overstuffed cushions, repairing, 159

Pack, back, 81
Pad-and-calender holder, 226
Paddles, gluing, 54
Pads, kneeling, 205
Paintbrush, cleaning, 101
Paint dippers tin-can, 184
  sprayer, 182
Painting, water line, 108
Paint-shop stand, 175
Paints, modelmaker's, keeping, 190
Panels, aluminum, making, 291
Paper clips, use in wiring, 208
Paper knives, 224
Patterns for turnings, 139
Pencil, electric, 308
  greaseless-lubricant, 292
Perpetual calendar, 145
Pewter, plating with, 180
Photoelectric cell, 286
Photo colors, used to dye wood, 104
Photographic darkroom, 273
Photographs, taking with printing frame, 270
Photography, filters, 276
  reflector for lamps, 278
  table-top, 275
Photomicrographs, glass stage for, 280
  making, 279
Pickaninny pipe rack, 124
Pictures, inlaid wood, 121
Picture-frame moldings, 135
  radio, 298
Picture frames, making, 137
Pinhole camera, 275
Pin stripes for models, 189
Pipe rack, novelty, 124
Pipe, bench legs made from, 248
  dowels made with 256
  vise guides made from 265
  threading, 334
Planes, thumb, 264
Planetarium, 316
Plant. grown in bottle, 202
Plaster, nail hole in 178
  fastening nails in, 205
  ornaments, casting, 27
Plates, wire-drawing, 244
Platform, clothes-drier, 214
Plating, brass bowls, 180
  current for, 302
  metal on wood, 300
  with solder, 284
Playground, back-yard, 46
Play house, children's, 197
Plywood edges, finishing, 188
Pocket weather forecaster, 333
Polishing with eraser, 248
Pool, rustic, 197
  table, 48
Popcorn server, 140
Porch glider, 199
  lamp, metal, 224
Portable darkroom, 274
  easel, 256
Power hack saw, 254
Printing box, photographic, 269
  frame, 270
Privateer model, 91
Projector, 42
Proportional dividers, 241
Punches, rack for, 236
Putty, glazing, 176
Puzzle, peg, 39

Racing runabout, 60
  schooner, model, 102
Rack, auger-bit, 241
  for punches, 236
  for turning tools, 122
  magazine, 160
  newspaper, 136
Racket, tennis, stringing, 85, 138
Radio, amplifier, 293
  arm-chair set, 294
  lamp, made from bottle, 22
  picture-frame, 298
  portable transmitter, 296
Radius-turning tool, 266
Razor hone, 25
Recording drum, 322
Reels, ball-bearing, 90
Reflector baker, 65
  flashlight, 290
  for photography, 282
  tinfoil, 278
Refrigerator unit, 252
Relay, supersensitive, 288
Repairing key-case snap, 260
  overstuffed cushions, 159
Resins, cast, 11
Rings, celluloid, 9
Rocket-race game, 40
Rod, casting, 73
Rollio game, 39
Rope, for motor boat, 64
Rosettes, on book ends, 153
Rowboat, 66
Rubbing, varnish, 181
Rugs, slip-proofing, 104
Runabout, racing, 60
Rustic garden pool, 197
Rust. removing, 236

Sack for sawdust, 246
Safety pin, used as cotter, 122
Sail slides and track, 80
Salad-jar lantern, 230
Sanding block, 258
  disk, cement, 236
Sandpaper, holding in vise, 261
  keeping in tins, 242
Satin finish for furniture, 181
Sawdust, sack for catching, 246
Schooner, model, racing, 102
Screens, for steel casements, 215
Screw driver holds bolthead, 131
Screws, fixing loose, 290
Sealers, using, 177
Sealing wax, 178
Secret compartment, in lamp, 136
Seesaw, 44
Seismograph, 326
Server, cigarette, 229
Seven-in-one game table, 45
Seven-shaped lamp, 143
Sextant, 309
Sheet metal, cutting with acid, 219
Ship models, coloring, 185
Shoe brush, cleaning, 158
Shop lighting, tests for, 234
Shower curtain, 214
Sighter, star, 314
Signs, model-railway, 109
  shop, 132
Silhouette decoys, 77
Skagway skizzer, 86
Skate, snow, 86
Slippers, knot work, **17**
Slant-top desk, 157
Smoker's set, lead, 228
Smoking set, cast resin, 14
  stand, modernistic, 130, 146
Smoothing small carvings, 101
Snap, key-case, repairing, 260
Snow-and-ice novelties, 86
Snow cruiser, 86
Snowshoes, making, 83
Soldering, acid tray, 256
Solder, keeping clean, 268
  coating metal with, 284
Spanish table, 163

Spider-web cross hairs, 328
Spirals, in metal tubing, 223
Split-hundredths, measuring, 246
Sportsman's cabinet, 52
Sprayer, paint, 182
Spring holder for brads, 266
Square-knot work, 15, 17
Square, take-down bevel, 258
Stage, for photomicrographs, 280
  microscope, 318
Stamps, enclosing in letter, 259
Stand, bicycle, 30
  cake, 170
  flower, 151
  paint-shop, 175
  smoking, modernistic, 130, 146
Star, Christmas, 25
  measurements, 314
  sighter, 314
Steam box, 76
Steam-electric wall-paper remover, 209
Steam engine, model, 106
Steel casements, screens for, 215
Stencil, hinged, 190
Step-down transformer, 304
Sticks, throwing, 53
Stovepipe, used as steam box, 76
Straightening turned bars, 237
Studio couch, made from davenport, 208
  with inner-tube springs, 147
Stuffing-box leak, 82
Submarine, toy, 30
Sundial, laying out, 329
Supersensitive relay, 288
Surf boards, 56
Swallow, model of, 91
Swimming board, hollow, 58
Swinging shop signs, 132

Table, camp, 74
  coffee, 167
  drafting, 150
  drop-leaf, 164
  game, 45
  pool, 48
  Spanish, 163
  tennis, 47
  three-in-one, 171
  tile-top, 162
  tip-top, 168
Table lamp, geographical, 125
  in form of tree, 124
  nautical, 133
Table-top photography, 275
Tables, veneering, 126
Tap-and-die case, 252
Taper-cutting jig, 261
Tap guide, 250, 256
Target, archery, 76
  bean-bag, 40
Teeter-totter and whirligig, 44
Telescope, clamp, 332
  equatorial, 312
  eyepiece turret, 315
Telltales, model-railway, 101
Testing gold, 228
Test tubes, keeping paint in, 190
Tests for workshop lighting, 234
Thermal-hunter airplane model, 111
Thermometer, electrical, 306
Thermometer, test for humidity, 311
Thermostats, adjusting, 194
Thin stock, corner joints, 263
Threading pipe, 334
Three-in-one table, 171
Throwing sticks, 53
Thumb planes, 264
Ticket-dropping airplane, 33
Tile-top table, 162
Tiller, hooking up, 88
Tilt top for tripod, 270, 280
Tin-foil designs, 222
Tip-top table, 168
Tool cabinets, 244, 249
Tool, marking fluid, 176
  radius-turning, 266
  demagnetizing, 284
  marking, 301
  removing rust, 236
Top, walking, game, 43
Torch, acetylene, 241
Toys, made from coffee-cans, 48
Tray, acid, lead-covered, 256
  one-handed, 124
  with turned moldings, 144
Trays, ash, 228
  with animal handles, 129
Tree-stump book ends, 140
Trellises, 200
Tripod, camera, 271
  tilt-top, 270
  tilting head, 280
Transformer, making, 304
Transmitter, radio, portable, 296
Transparent cover for microscope, 328
Trolling disk, 79
Trowel, made into sanding block, 258
Tubes, neon, 285
Tubing, metal, ornamenting, 223, 225
Turnbuckles, model, 117
Turned work, finishing, 178, 188
Turning tools, rack for, 122
Turnings, patterns for, 139
Turret, eyepiece, for telescope, 315
Tuscaloosa, model of, 105
Twisted flower stand, 156
Two-piece tap guide, 256
Typewriters, cleaning, 28
Typewriting on metal, 301

Umbrella, beach, improving, 82
Universal joint for telescope, 332
Vacuum-cleaner motor, 256
Vacuum dust-removing system, 231
Varnishing furniture, 179
Varnish, rubbing, 181
Vase holder, 227
V-block for welding, 252
Veneering, boxes, 123
Tennis racket, stringing, 85, 138
  table, 47
  half-round tables, 126
Venetian blinds, 201
Ventilator, in roller shade, 193
  window, 218
Vinegar, used to clean boiler, 250
Vises, drill-press, 252
  bending jig for, 254
  holding sandpaper in, 261
  tennis-racket, 138
  woodworking, 265

Waders, fishing, 80
Walking-top game, 43
Walls, clamp-proofing, 176
Wall-paper remover, 209
Wastebaskets, decorative, 16, 153
Watch, adjusting, 241
  demagnetizing, 284
Watch guard, square-knot, 15
Water line, painting, 108
Weather bureau, setting up, 321
  forecasting chart, 333
  guide, 319
  vanes, 325
Webbing, used to clamp joints, 146
  steel strips replace, 150
Weeds, killing, 202
Welder, arc, 307
Welding, V-block for, 252
Whirligig and teeter-totter, 44
Whirling toys, 39
Wind gauge, 320
  in weather vane, 325
Windmill, yacht-race, 126
Window shade, ventilated, 193
Window ventilators, 218
Wing chair, Chippendale, 148
Wiper, brush, 180
Wire-drawing plates, 244
Wires, fastening to baseboard, 208
Wooden balls, turning, 142
  monkeys, 32
Wood, plating metal on, 300
  screws, fixing loose, 290
Woodworking vise 265
Workbenches, 253
  boy's, 34
Workshop, laying out, 247
  microscope uses in, 238
Writing on metal, 308
Wrought iron, finishing, 187

Yacht model, aligning, 101
Yacht-race windmill, 126

CYCLO-
PEDIA
OF
Things
to
Make

GROSSET
& DUNLAP